

**ANALYZING SERVICE QUALITY VIA QFD AND  
SERVQUAL: APPLICATIONS IN ACCOMMODATION  
SERVICES AND DISTANCE LEARNING**

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SERVICES AND DISTANCE LEARNING**

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## **SUMMARY**

Service quality has become one of the most researched areas today, because the service industries are playing a more and more important role in the overall economy of the world. This thesis focuses on issues about how to analyze, measure and improve service quality in specific educational settings. Quality Function Deployment (QFD) is a systematic tool to translate customer requirements into appropriate technical requirements. A case study of identifying and meeting students' needs of accommodation services is presented. Furthermore, a popular approach to measure service quality is SERVQUAL. In this thesis, another case study presents how to measure service quality of Internet-based Learning provided by a Chinese major distance learning services provider. It also overcomes linguistic problems by employing fuzzy set theory.

This thesis consists of 6 chapters. Chapter 1 is a brief introduction of this thesis. Chapter 2 is a literature survey that provides a thorough review of two existing research methods for evaluating service quality, QFD and SERVQUAL. Chapter 3 presents a proposed process model to employ fuzzy set theory in SERVQUAL to evaluate service quality. Following this, two case studies are presented in Chapters 4 and 5. Chapter 4 is an application of QFD in student accommodation services by the National University of Singapore. It demonstrates how QFD can be used to measure customer satisfaction in an important component of higher education. Chapter 5 presents a survey conducted in a Chinese major distance learning services provider, which aims to analyze and evaluate service quality in Internet-based Learning. This is



based on the SERVQUAL model. We deal with some limitations of the SERVQUAL model in this chapter: unstable dimensionality and ambiguity of inputs. A method of measuring perceived service quality based on triangular fuzzy numbers is used in this chapter. At the end of the thesis, the conclusion is given in Chapter 6.

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## **NOMENCLATURE**

AHP	analytic hierarchy process
AI	artificial intelligence
BNP	best nonfuzzy performance
CRAD	customer requirements analysis and deployment
DSS	decision support system
ELS	e-learning system
GSS	group support system
HOQ	house of quality
IS	information system
MBNQA	malcolm balridge national quality award
MCDM	multicriteria decision making
OCRA	operational competitiveness rating
QFD	quality function deployment
QM III	quantification method of type III
TOPSIS	technique for order preference by similarity to ideal solution
TQM	total quality management
TVM	total values management
UIS	user information satisfaction
USISF	user satisfaction with the information service function
VOC	voice of the customer
ZMET	zaltman metaphor elicitation technique

# **Chapter 1**

## **Introduction**

### **1.1. Research Background and Motivation**

It is common knowledge that improvement in our standard of living is highly dependent on better quality in the service sector. Services are taking on increasing importance in the worldwide economy. To compete effectively in today's vigorous global competition, service providers have realized that they must instill and practice service quality throughout their organizations to survive and grow. The interest in service quality parallels the focus on quality, Total Quality Management (TQM), and satisfaction in business (Fisk et al., 1993).

In today's changing global environment, many educational institutions are also facing intensifying competition. In order to achieve competitive advantage and efficiency, institutions have to seek ways to differentiate themselves. Higher education possesses all the characteristics of a service industry (Shank et al., 1995). One strategy that has been related to success is the delivery of high service quality, especially during times of intensive competition both domestically and internationally (Rao and Kelkar, 1997). This concept has been the subject of many conceptual and empirical studies, and it is generally accepted that service quality has positive implications for an organization's performance and competitive position, same to an educational institution.

The study of service quality should be aimed at understanding, meeting and surpassing customer needs and expectations. There are many methods that can be

used to study service quality. The following two prominent methods are employed to study service quality frequently: Quality Function Deployment and SERVQUAL. QFD is a customer-oriented planning process for translating customers' needs into technical requirements at every stage of a product's life cycle and it also has been introduced into the service sector to design and develop quality services. SERVQUAL is one of the most widely used instruments to evaluate service quality, which defines service quality as the gap between predicted service and perceived service.

However, despite the vast amount of research done in the area of service quality in education, quality related issues have received little research attention other than teaching activities. First, although QFD has been applied in higher education for many years, most has been focused on research and teaching (Chan and Wu, 2002). Few efforts, however, have been paid to improve the quality of education in other activities, like accommodation, enrollment, and extra-curricula activities. Second, distance learning is increasingly popular and becoming a complementary way of learning in formal education at schools as well as in continuous education of employees, because of its advantages over the traditional education courses. An overwhelming number of distance learning programs now are available through a multitude of delivery mechanisms, especially the Internet. To respond to this demand, universities and other centers of higher education must recognize and meet the needs of learners who are quite different from the traditional students of the past. Although many conceptual and empirical studies have been done in the area of service quality, however, quality issues related to distance learning, especially for online programs, have received little research attention (Fresen, 2002 and Sonwalkar, 2002).

The above reasons mentioned motivated us to undertake this study. Besides, services have many characteristics that make the evaluation of quality much more

difficult than hard products. These characteristics include intangibility, heterogeneity, variation, subjection, customer participation and perishability (Chen, 2001). Since many intangible factors and the customers' subjective judgments can influence customer satisfaction, measuring service quality becomes a great challenge for every organization.

## **1.2. Objective of the Thesis**

This exploratory research focuses on how to analyze and improve service quality to achieve final excellence in specific educational settings. This study attempts to address the following three issues:

First, how to address the ambiguity and the subjectivity of the customers' judgments in the measurement of service quality?

Second, how to use QFD and SERVQUAL to analyze, evaluate and improve service quality?

Third, what should we know in order to improve service quality in accommodation services and distance learning?

By employing QFD, SERVQUAL and fuzzy set theory, this thesis explores the above three issues and provides their feasible solutions.

## **1.3. Structure of the Thesis**

This thesis consists of six chapters. The contents of each chapter are summarized as follows. Chapter 1 is a brief introduction to this thesis. Chapter 2 is a literature survey that provides a thorough review of the following two existing research methods for analyzing service quality: QFD and SERVQUAL. In Chapter 3, how to employ the fuzzy set theory with SERVQUAL is discussed. The proposed

process model employing the fuzzy set theory in the service quality evaluation is developed.

Two case studies have been conducted and are presented in Chapter 4 and Chapter 5. Chapter 4 is an application of QFD in student accommodation services by the National University of Singapore. It demonstrates how QFD can be used to measure customer satisfaction in an important component of higher education. Chapter 5 presents a survey conducted in a Chinese major distance learning services provider, which aims to analyze and evaluate service quality of Internet-based Learning, based on the SERVQUAL model. In this application, we deal with some significant limitations of the SERVQUAL model. First, the number of dimensions in SERVQUAL is not unique, which is called unstable dimensionality. Second, when applying the SERVQUAL model, many intangible attributes, which are difficult to measure accurately, will result in the ambiguity of inputs. A method of measuring the perceived service quality based on triangular fuzzy numbers is used in this chapter.

Finally, in Chapter 6, we present the conclusions and also outline areas for future research.



## **Chapter 2**

### **Literature Review**

With a view to identify the main framework for this research, the aim of this literature review is to provide an initial mapping for the origination and development of QFD and SERVQUAL including some limitations in the existing culture, which stress the motivation of this study.

#### **2.1. Service Quality**

From a review of the literature on quality, it has been found that early research efforts concentrated on defining and measuring the quality of tangible products, while the service sector was ignored. Gronroos (1990) noted that product quality was traditionally linked to the technical specification of goods, with most definitions of quality arising from the manufacturing sector where quality control has received extensive attention and research. Crosby (1979) defined quality of goods as “conformance to requirements”; Juran (1980) defined it as “fitness for use”; and Garvin (1983) measured quality by counting the frequency of “internal” failures (those observed before a product left the factory) and “external” failures (those incurred in the field after a unit had been installed). These product-based definitions of quality may be appropriate to the goods-producing sector. However, knowledge about the quality of goods is insufficient to understand service quality (Parasuraman et al., 1985).

Services are generally described in terms of four unique attributes (Lovelock, 1981; Gronroos, 1990; Zeithaml and Bitner, 1996), namely:

- Intangibility
- Heterogeneity
- Inseparability
- Perishability

Oldfield and Baron (2000) proposed that service quality is made up of three significant dimensions: service processes, interpersonal factors, and physical evidence. Service processes are the system of company policies and the system of service delivery that a service provider adopts, which will determine the way the service is provided to the customer. For example, in some instances, the rigid nature of an organization can cause dissatisfaction when employees are unable to deliver good service to a customer (Normann, 1991). Additionally, it has been suggested that frontline employees can influence the degree of satisfaction that a customer experiences (Bateson, 1977; Bitner et al., 1990).

Interpersonal factors illustrate that the interaction between customer and service organization is also critical to quality service. People who deliver the service are of key importance to both the customers they serve and the employer they represent. For example, the employee's manner and appearance all play a part in determining how satisfied the customer is with the service encounter.

Physical evidence is concerned with the tangible elements associated with a service. Customers cannot see a service but they can see and experience various tangible elements associated with the service, such as facilities, employees, pamphlets, leaflets, etc.

A more popular understanding of service quality is that five principle dimensions are identified for customers to use to judge service quality. Customers use those dimensions to make their assessment, which are based primarily on a comparison of their expectations of the service desired with their perceptions of the service delivered. This popular definition of service quality is shown in the Figure 2.1. And service quality gap model demonstrates that five different types of gaps could occur when customers' expectations do not meet their perceptions of the service (see Figure 2.2):

1. Gap between consumer expectation and management perception, which results from a lack of understanding of what consumers expect.
2. Gap between management's perception and service quality specifications, which results from a difference between the established service quality specifications and what the management perceives to be customer expectations.
3. Gap between service quality specifications and service delivery, which results from a discrepancy between service quality specifications and inadequate service delivery, such as, poor employee performance.
4. Gap between service delivery and external communications, which results from a discrepancy between the quality delivered and the quality promised in the service provider's promotional message.
5. Gap between perceived service and delivered service, which results from the previous gaps.

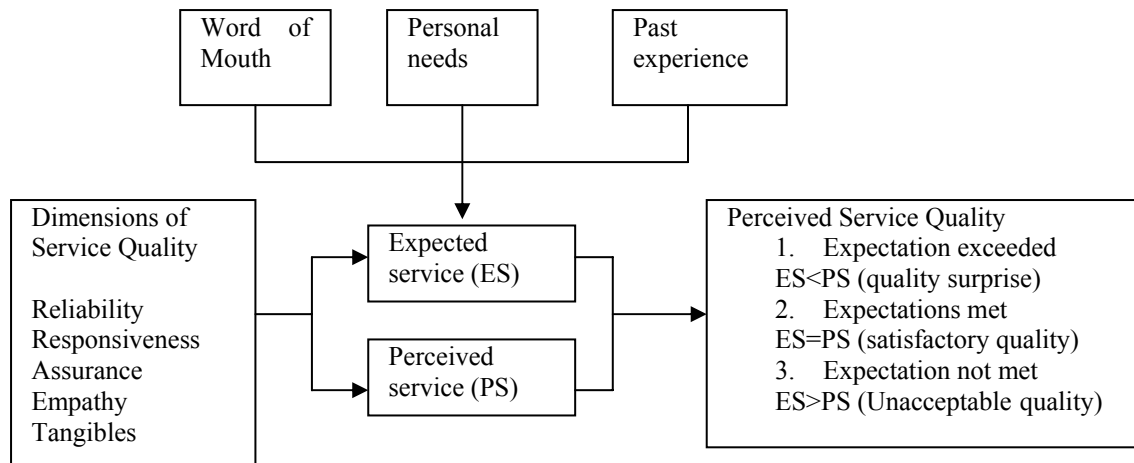


Figure 2.1. Definition of service quality (reproduced from Fitzsimmons and Fitzsimmons, 2001)

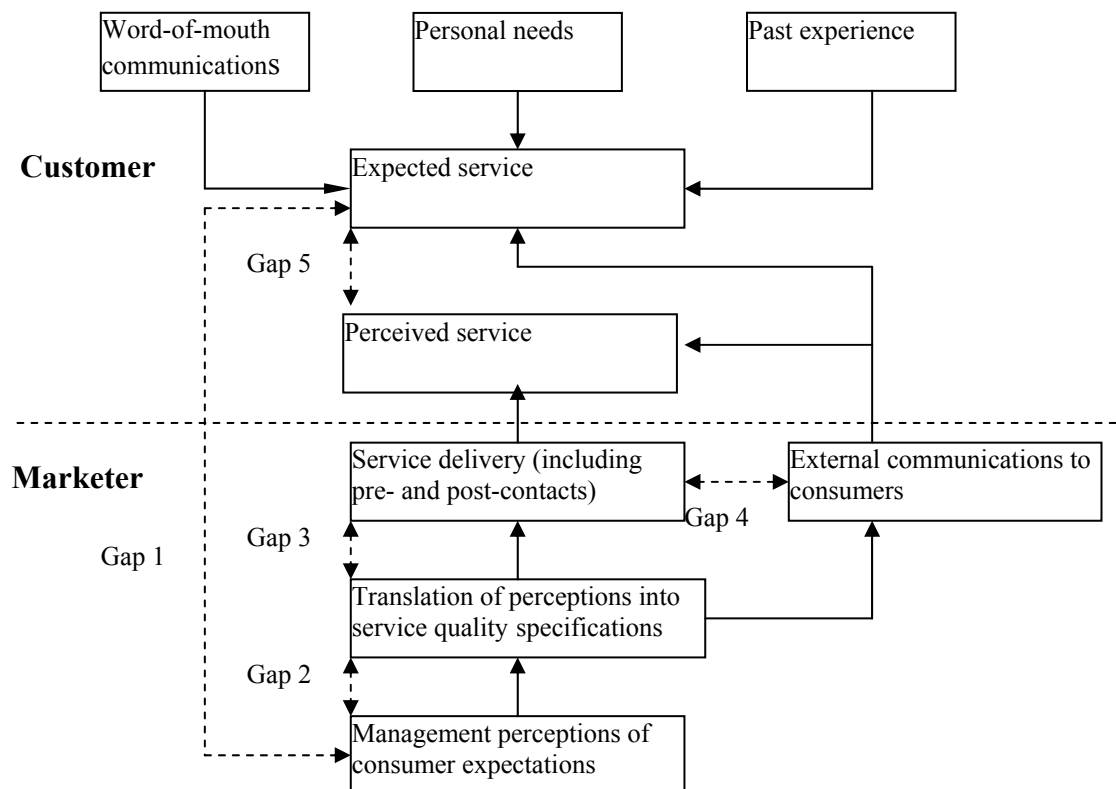


Figure 2.2. Service quality gap model (reproduced from Parasuraman et al., 1985)

## 2.2. QFD

QFD comes from the original Japanese phrase: *Hin Shitsu Kino Ten Kai* (Lockamy III and Khurana, 1995), and the three characters mean:

- *Hin Shitsu*, which usually means quality, feature or attribute;
- *Kino*, which usually means function or mechanization; and
- *Ten Kai*, which usually means deployment, diffusion, development or evolution.

Akao (1990) defined QFD as converting consumers' demands into "quality characteristics" and developing a design quality for the finished product by systematically deploying the relationships between the demands and the characteristics, starting with the quality of each functional component and extending the deployment to the quality of each part and process. According to Sullivan (1986), QFD is an overall concept that provides a means of translating customer requirements into the appropriate technical requirements for each stage of product development and production.

In general, QFD is a management tool that provides a structured method for translating customer needs and expectations into the technical requirements for each stage in product or service development. Its power lies in the fact that it uncovers an organization's processes and how these processes interact to create customer satisfaction and profit (Raynor, 1994).

### 2.2.1. History of QFD

QFD is a method developed in Japan in the late 1960s under the umbrella of total quality control to provide a map for interfunctional planning and communication (Akao, 1990). In 1972, when QFD was applied at the Kobe shipyards of Mitsubishi

Heavy Industries in Japan, it emerged as a viable methodology. It rapidly spread to the US in the 1980s and later to many countries in many industries. In the US, the first recorded case study in QFD was in 1986 (King, 1989). Kelsey Hayes used QFD to develop a coolant sensor, which fulfilled critical customer requirements like “easy-to-add coolant”, “easy-to-identify unit” and “provide cap removal instructions”. Later, a great literature on QFD evolved (Chan and Wu, 2002).

### **2.2.2. QFD Models**

QFD has two popular models to illustrate its process. One is the four-phase model developed by Clausing (1994): House of Quality (HOQ), Parts Deployment, Process Planning, and Production Planning. The four-phase model is based on the following four components (Sullivan, 1986):

1. Overall customer requirement planning matrix - translates the general customer requirements into specified final product control characteristics;
2. Final product characteristic development matrix - translates the output of the planning matrix into critical component characteristics;
3. Process plan and quality control charts - identify critical product and process parameters and develop check points and controls for these parameters; and
4. Operating instructions - identify operations to be performed by plant personnel to ensure that important parameters are achieved.

The other model is called the “Matrix of Matrices” by Akao (1990). It is normally presented as a system of thirty matrices, charts, tables, or other diagrams, which is considered tremendous and far-reaching and is not dominated in the QFD literature (Cohen, 1995).

### **2.2.3. House of Quality (HOQ)**

The HOQ is the most commonly used matrix in the traditional QFD methodology. To deploy the voice of customer (VOC), a well-designed questionnaire is needed to find out what customers want. This information then needs to be incorporated into the design, through the HOQ technique. HOQ is a kind of conceptual map that provides a means for inter-functional planning and communications (Hauser and Clausing, 1988).

HOQ recognizes the inter-relationships between customer requirements and design variables and between the design variables themselves. The technique appears complex, but in reality it is no more than a method of organizing and analyzing information. Figure 2.3 below shows the basic HOQ model. The numbered paragraphs that follow, which work through the model one step at a time, are cross-referenced with the figures in the diagram (Fuller, 1998).

1. List Customer requirements in “What”.
2. Rate them in order of importance from 1 to 10 (with 10 being “essential to the customer”).
3. In “How”, list how you are going to satisfy the specific customer wants - i.e. the basic elements of design to satisfy the customer requirements.
4. In the Relationships Matrix, cross-reference the strong, medium and weak relationships. As the top box indicates, they often carry points of 9, 3, and 1 respectively.
5. The “roof” of the house is designed to cross-correlate the “How” against each other so that the conflicting and complimentary characteristics can be identified. The arrows under the roof indicate whether the design aspect is

preferable at its maximum value. This indicates the direction in which you are trying to design your product or service.

6. If required, it is possible to incorporate a benchmarking study. The symbols are used to indicate comparative performance.

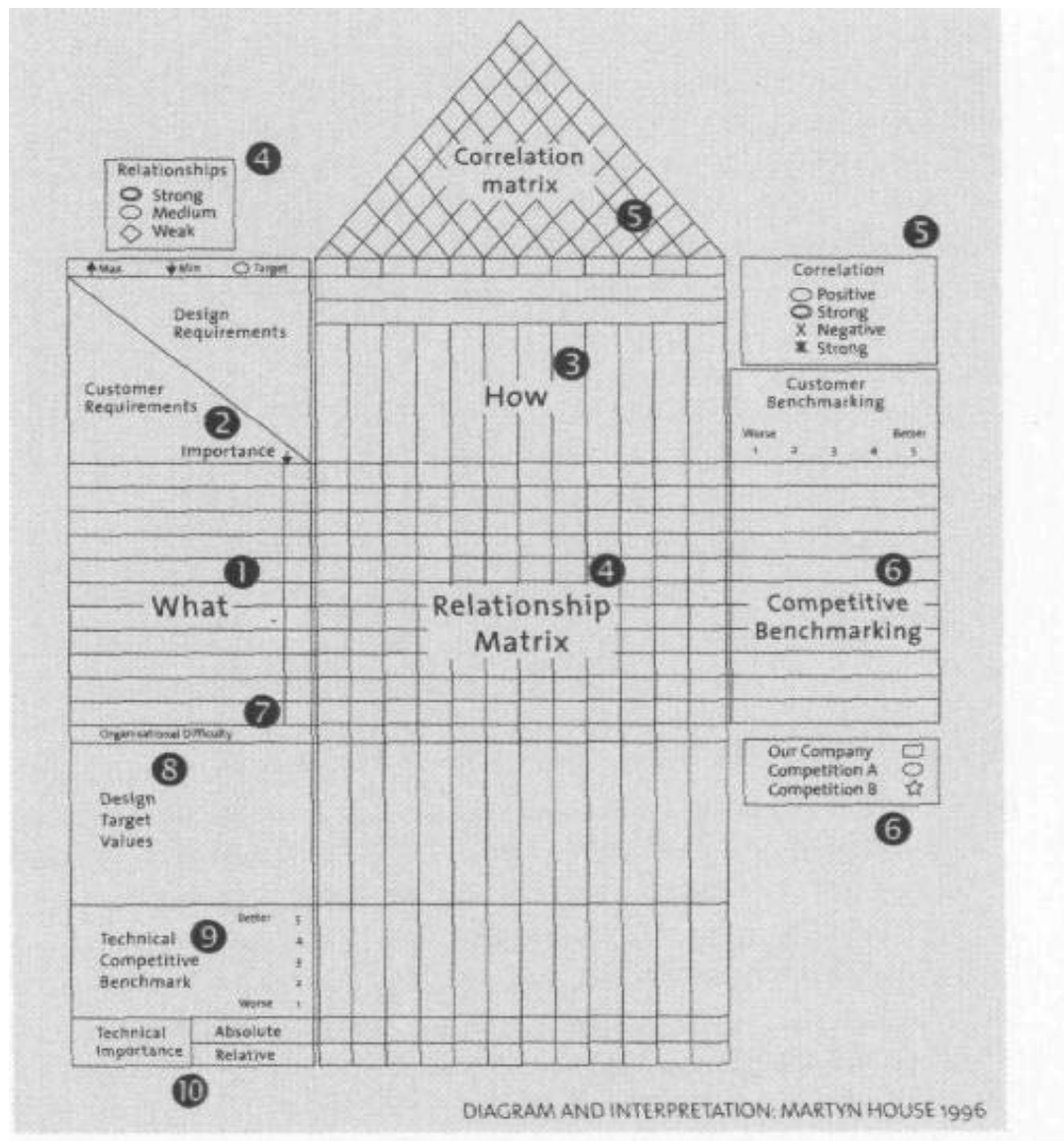


Figure 2.3. Diagram of HOQ (reproduced from Fuller, 1998)

7. The organizational difficulty row can be included to indicate the degree of difficulty in achieving that particular design feature.



8. The design target values in this section are for the listing of the specific overall design values.
9. This section is optimal and is the technical benchmarking grid. Here, a comparison between the basic technical specification and the competition can be made.
10. The final grid is for prioritizing the design program. First, an absolute rating is obtained from importance multiplied by strong/medium/weak relationships, and then adding all the vertically generated figures. Finally, relate them to each other, such that the highest absolute rating is given the priority number.

The process of building the HOQ is quite different from building a real house. First, the HOQ constructions begin with the left room - the collection of customer needs and their prioritization. Second, the technical characteristics that will satisfy the customer requirements are figured out. Third, after gathering the VOC and coming up with technical characteristics, we should build the center of the HOQ, which indicates how each technical characteristic affects each customer need. Thereafter comes the construction of the roof of the HOQ. This is a matrix indicating relationships among technical characteristics. The roof is a good indicator of future design trade-off that may have to be made. Finally, we should build the technical matrix. This last section contains the most important and useful information that may be considered as the output of the HOQ. The technical priority provides a rank ordering of the technical characteristics. This serves as a guide for making trade-offs in resource allocation. Additional information in this section may consist of technical difficulties, estimated costs, and the determined importance of meeting a particular target specification.

#### **2.2.4. Benefits of QFD**

QFD is widely accepted because of its benefits. Bum (1994) summarized the benefits of the QFD approach as follows:

- Improved quality;
- Increased customer satisfaction;
- Improved company performance;
- Improved time to market;
- Lower cost in design and manufacture;
- Reduction in design changes/problems; and
- Improved product reliability.

#### **2.2.5. Major Pitfalls of QFD**

Despite QFD's benefits, there are also many limitations reported by the organizations that try to implement QFD. Prasad (1998) summarized the pitfalls of QFD:

1. It would be a complex undertaking, considering just the size of the resulting relational matrices in QFD.
2. Deploying them serially would be a long-drawn process.
3. Cascading the requirements all together as what was done in the case of quality functions would be large and clumsy to handle.
4. The design obtained through this combinatorial QFD process would result in a sub-optimized design, that is, a product particularly designed for characteristics related to quality.

The major limitations of QFD are discussed in detail as follows. One pitfall of the conventional QFD is that it is based on a single measurement, mostly quality plans. Today, manufacture and service sectors are more fiercely competitive and global than ever. Consumers are more demanding, competition is more global, fierce, ruthless, and technology is advancing and changing rapidly. The quality-based philosophy inherent in Akao's QFD style, which was introduced during the early 1970s, does not account for the time factor inherent in today's complex process. Competitors are always finding better and faster ways of doing things. What is required is a total control of the process - identifying and satisfying the needs and expectations of the consumers better than the competitors and doing so profitably faster than any competitor (Clausing, 1994).

Next, QFD is a phased process. The conventional deployment process in QFD prescribes a set of structured cross-functional planning and communication matrices for building quality as specified by customers into a product. Such a methodology is described by Sullivan (1988) and is based on the most popular four-phased deployment proposed by Macabe, a Japanese reliability engineer in 1970 (Aswad, 1989). This is often represented in a cascade time-bound process where characteristics of a prior phase are fed as requirements for a subsequent phase. The serial nature of deployment tends to make the QFD process sequential. If each phase of deployment is a multipartite process, the elapsed time can be significantly large. The total time that QFD would take will be elongated.

Another limitation of QFD is one-dimensional. The roles of the organization and engineers are constantly changing today. Competition has driven organizations to consider concepts such as time compression (fast-to-market), concurrent engineering, design for X-ability, and tools and technology (Taguchi, TRIZ, value engineering and

technological forecasting methods, etc.) while designing and developing a product. QFD addresses major aspects of quality plans with reference to the functions that a product has to perform, but this is one of the many functions that needs to be deployed. With conventional QFD, it is difficult to address all aspects of total values management (TVM), such as X-ability, cost, tools and technology (Pandey, 1992), responsiveness, and organization issues (Carey, 1992). It is not enough to deploy quality into the product and expect the outcome to be world-class (Prasad, 1997). Some researchers believe that TVM efforts are vital in maintaining a competitive edge in today's world market. The question is how to deploy all the aspects of TVM.

Furthermore, QFD cannot account for the increasing complexity of a product and the conflicting requirements that need to be addressed (Prasad, 1998). QFD may not be robust enough to accommodate multiple-function deployment to result in products that optimally meet customer requirements. Pandey (1992) proposed that conventional QFD process lacks the vigor while implementing simultaneously various conflicting value characteristics such as cost, responsiveness, quality, and so on. As a result, the conventional QFD process will be repeated for each value once at a time, which elongates the product development cycle time into a multiyear tribulation.

One of the other QFD's problems is that uncertainties are introduced because the starting point is often a questionnaire or an interview conducted by the marketing department (Khoo and Ho, 1996). Fuzzy logic is one way to manage uncertainties.

## **2.2.6. Development of QFD**

### **2.2.6.1. Voice of Customer (VOC)**

The VOC is considered as the backbone and the input to the whole QFD process. VOC analysis is very crucial because QFD users cannot get an inaccurate

representation of customer desires at the beginning. As the backbone of QFD (Shillito, 1994), VOC includes two aspects, i.e. qualitative and quantitative. Usually what customers want (qualitative VOC) and how they prioritize their wants (quantitative VOC) can be collected by listening to the VOC.

Many techniques have been used in QFD to help collect the VOC, including surveys, focus groups, interviews, customer complaints, and direct observations (Shillito, 1994; Cohen, 1995). However, traditional techniques have pitfalls, such as failure to provide the details required for the product or service planning in QFD environment, or barriers to listening to VOC, e.g., respondent bias and rehearsal effect. Klein (1990) introduced VOCALYST, a new technique which includes a four-step process to systematically collect and structure the VOC. Zaltman and Higie (1993) proposed the Zaltman Metaphor Elicitation Technique (ZMET) to understand customers by employing a personal interview to elicit the metaphors, constructs, and mental models that drive customers' thinking and behavior. Griffin and Hauser (1993) provided a comprehensive discussion on VOC about its identification, structuring and prioritization. Analytic Hierarchy Process (AHP) was firstly proposed by Saaty (1980), and was then used in QFD by many researchers, such as Akao (1990), Zultner (1993), Armacost et al. (1994), Lu et al. (1994) and Doukas et al. (1995). AHP is a multi-criteria decision making technique, which is particularly useful for evaluating complex multi-attribute alternatives involving subjective and intangible criteria. Conjoint analysis was also proposed to find the most valuable quality attributes to customers (Gustafsson et al., 1999). The Kano Model was combined with QFD for understanding the nature of VOC and for successful product development projects (Matzler et al., 1996; Matzler and Hinterhuber, 1998). Tan et al. (2000) incorporated Kano's model into the planning matrix of QFD to help understand the nature of VOC

more accurately and deeply. Based on the Kano model analysis, they proposed an approximate transformation function to adjust the improvement ratio of each customer's attribute and customers' raw priorities, accordingly for achieving the desired customer satisfaction performance.

#### 2.2.6.2. Prioritization Methods

Linking customer requirements to technical characteristics qualitatively and quantitatively is one of QFD's advantages. Traditionally, technical characteristics can be prioritized according to their additive impacts on customer requirements using a relationship matrix and adopting a particular scale. However, given limited resources, prioritization is essential in guiding QFD users to make trade-offs in the selection of different technical characteristics.

Various approaches from different perspectives have been proposed in the prioritization phase, e.g., the relatively arbitrary setting of the numerical scale, the conversion of ordinal to cardinal scale, and the less utilization of the roof matrix. Basing on Lyman's (1990) deployment normalization, Wasserman (1993) proposed a prioritization method for taking the correlations among the technical characteristics into account, and suggested the use of the technical importance to cost index in prioritizing the allocation of resources. Franceschini and Rossetto (1995) used multiple criteria decision aid methods for ranking technical characteristics. It showed that the avoidance of the rigid procedure of turning relationships from an ordinal scale into a cardinal scale could be achieved. Chan and Wu (1998) proposed two new techniques for better prioritization of technical characteristics. They considered HOQ as a typical multiple attribute decision making process, and considered prioritization as an assessment for the performances of technical characteristics. Therefore, the

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Operational Competitiveness Rating (OCRA) were applied. Wang et al. (1998) extended AHP from the prioritization of customer requirements to the technical characteristics. Wang (1999) viewed QFD as a multi-criteria decision problem and introduced a new fuzzy outranking approach that was able to handle the evaluation results with linguistic terms or prioritize technical characteristics.

Prioritizing technical characteristics is important in allocating resources and guiding downstream analysis, but it provides the information in a general, non-specific form. It may be necessary to determine the specific value for each technical characteristic. From the viewpoint of design process, Belhe and Kusiak (1996) modeled the problem of determining optimal values of design process variables to maximize the combined quality index of the critical design process variables. On the basis of multi-attribute utility theory, HOQ was interpreted and formulated as a multi-objective optimization problem with constraints derived from the HOQ and physical laws (Thurston and Locascio, 1993; Locascio and Thurston, 1998). Franceschini and Rossetto (1997) developed a Qbench algorithm for designing a product's technical quality profile, according to the availability of the technical benchmarking information. This was further modified by Franceschini and Zappulli (1998) and applied to a real case for an important automobile firm. In order to determine the target values of technical characteristics, Kim (1997) developed a prescriptive modeling approach to maximize the overall customer satisfaction under the system and budget constraints.

All the above analyses on the determination of technical priorities and targets are based on the assumption that all the identified technical characteristics will be integrated into the subsequent process. Because resources are limited, it might be

useful to establish the minimum or optimal set of technical characteristics, which are able to answer globally all customer requirements or maximize customer satisfaction. Park and Kim (1998) developed a mathematical programming-based approach to determine an optimal set of technical characteristics in order to search for the minimum set and then focus the design attention on the main characteristic. Its aim is to maximize the total absolute technical importance rating from selected technical characteristics, which represents the magnitude of customer satisfaction.

Franceschini and Rupil (1999) discussed in their paper about the rating scale and prioritization in QFD. Some potential problems that could arise during the elaboration and interpretation of collected data were exhibited. It was illustrated that the final ranking of the technical characteristics was highly dependent on the scale used. Particularly, it showed that ratings derived from a linear interval scale could lead to a wrong ranking of technical characteristics if interpreted as derived from a proportional scale. To validate the robustness of QFD, Ghiya et al. (1999) discovered that changing correlation values caused the most significant changes.

#### 2.2.6.3. Simplification and Computerization of QFD

The large size of a HOQ and subsequent matrices may be obstacles to the application of QFD. It is time-consuming and difficult to assess the relationships between each customer attribute and technical characteristic. Because of the relatively large size of the HOQ, Hunter and Landingham (1994) revised the HOQ by deleting less important customer attributes and technical characteristics. To reduce risk involved in this approach, Kim et al. (1997) presented a formal approach to reduce the size of the HOQ chart using the concept of design decomposition combined with multi-attribute value theory. The HOQ chart was decomposed into smaller sub-



problems that could be solved efficiently and independently. Kihara et al. (1994) described a disciplined approach to use the Quantification Method of Type III (QM III) in QFD, which is a model technique of clustering diverse requirements into logical categories. By adopting factor analysis, Shin and Kim (1997) proposed a restructuring approach to create a new HOQ with a reduced number of technical characteristics. Later, Shin et al. (1998) developed a complexity reduction approach using correspondence analysis. It decomposes a HOQ into several small matrices and hence makes it easier to perform QFD in practice.

Franceschini and Rossetto (1998) proposed a partially automatic tool to define indirect correlations among technical characteristics, which focused on easy generation of the correlations among technical characteristics rather than the reduction of the HOQ size. However, the presence of an induced dependence of the requirements is necessary, but not sufficient, based on whether two technical characteristics are correlated. Some simpler versions of QFD were proposed for its earlier and faster usage, such as Blitz QFD. It was developed for QFD teams that have constraints on time, people, and money (Revelle et al., 1997). It demonstrates the selection and deployment of only the top most important ranked customer needs. There are five steps in Blitz QFD, that is: gathering the VOC, sorting the verbatim received from the customers, structuring the needs, deploying the prioritized customer needs, and analyzing only the important relationships in detail. CRAD (Customer Requirements Analysis and Deployment), another simplified version of QFD introduced by McLaurin and Bell (1993), was a four-step model called customer requirements analysis and deployment, a structured method for discovering customers' requirements and getting customer feedback on company performance.

In addition to the standard commercial QFD software systems, other computerized QFD systems were developed to serve different purposes. For example, in order to gain well-organized information so that customer requirements can be consistently met, Sriraman et al. (1990) suggested the use of object-oriented databases in QFD, as they are able to store, organize, and manipulate both customer requirements and product information.

Recognizing that the implementation of QFD was limited to a set of paper forms, Wolfe (1994) developed a hypertext-based group decision support system (DSS), which could provide support for strategic planning at the inception of each major system, and support for requirements management, coordination, and control throughout the development process. In order to implement QFD as a group productivity tool instead of an individual one, Balthazard and Gargeya (1995) proposed to develop an integrative technology that meshes QFD and group support system (GSS) initiatives. Maier (1995) suggested the representation of an entire hierarchy of QFD matrices in a single rectangular grid, which allows full QFD analysis on standard computer spreadsheets instead of a special purpose package. To analyze system interrelationships and obtain optimal target engineering characteristic values, Moskowitz and Kim (1997) developed an interactive, self-contained, and novice-friendly QFD DSS prototype.

#### 2.2.6.4. Use of Other Techniques

Fuzzy set theory (Zadeh, 1965) has been applied in QFD in the past years. Masud and Dean (1993) reported that how to perform QFD analyses when the input variables were treated as linguistic variables with values expressed as fuzzy members. Kim et al. (1994) introduced an integrated approach that allows a design team to

mathematically consider trade-offs among various customer attributes as well as the inherent fuzziness in the system by combining multi-attribute value theory with fuzzy linear regression and fuzzy optimization theory. Khoo and Ho (1996) developed an approach that is centered on the application of possibility theory and fuzzy arithmetic to address the ambiguity involved in various relationships. Fung et al. (1998) presented a hybrid system that incorporates the principles of QFD, AHP, and fuzzy theory to tackle the complex and often imprecise problems encountered in customer requirement management.

Reich (1996) discussed the AI-supported QFD and concentrated on the benefits that AI technology can offer to QFD in the process of information acquisition, use and communication. To embed QFD tools and their AI supporting tools, an architecture of a computational QFD was proposed in his paper.

By capturing and manipulating the knowledge of human experts, expert systems provide advantages of availability, consistency, and testability. The architectures for expert systems applied in quality management and QFD has been proposed (Crossfield and Dale, 1991; Bird, 1992). Zhang et al. (1996) suggested a machine learning approach, in which a neural network was used to automatically determine the data, and to avoid the need to input a large amount of data and the necessity of estimating values on a rather subjective basis in QFD. Kim et al. (1998) proposed a knowledge-based approach for constructing, classifying, and managing HOQ charts.

Group decision-making approach was integrated into QFD by Ho and Chang (1999). An integrated group QFD is a multi-disciplinary team process in which team member preferences are often in conflict with varied individual objectives. Both agreed criteria and individual criteria, if any, are considered simultaneously, whereas

AHP and others are based only on an agreed set of criteria. Specifically, the nominal group technique is modified to obtain customer requirements, and individual criteria methods are integrated to assign customers' importance levels in general situations where some members in a team have an agreed criteria set while others prefer individual criteria sets.

Customer satisfaction and delight are core values within the quality movement. Achieving customer satisfaction and delight in an economic way by finding the quality attributes most valuable to customers has become a key issue in today's design activities. Conjoint analysis is considered an excellent tool for this purpose. Conjoint analysis has recently been introduced as a tool supporting the use of QFD in the design process (Gustafsson et al., 1999). An attempt is made to illustrate a possible workflow for conjoint analysis and to give an example of the kind of information that can be collected by using the technique. Each step in the workflow is illustrated using a recent survey regarding the development of a total quality management course curriculum.

Besides, the Taguchi method has been proposed to help benchmark the first phase, and artificial neural networks may be used to deal with the large amounts of input data (Howell, 2000).

## **2.3. SERVQUAL**

### **2.3.1. Original SERVQUAL**

One of the most widely used instruments to measure service quality is the SERVQUAL scale developed by Parasuraman et al. in 1985, and then refined in 1988 and 1991.

In 1988, to derive a service quality measure that would transcend multiple measurement contexts, Parasuraman et al. developed SERVQUAL to measure the gap between customer expectations and services received. They found that customers used similar criteria in evaluating service quality. Based on data analyzed by four independent samples (banking service, credit card processing service, repair and maintenance service, and long distance telephone service), they presented a 22-item scale consisting of five service quality dimensions including:

1. Tangibles: The appearance of physical facilities, equipment, personnel and communication materials;
2. Reliability: The ability to perform the promised service dependably and accurately;
3. Responsiveness: The willingness to help customers and to provide prompt service;
4. Assurance: The knowledge and courtesy of employees and their ability to convey trust and confidence; and
5. Empathy: The provision of caring individualized attention to customers.

Service quality for each dimension is captured by a difference score,  $G = P - E$ , where  $G$  is the perceived quality,  $P$  is the perception of delivered service, and  $E$  is the expectation of service. In order to operationalise this model, the authors developed 22 items that were designed to capture customers' expectation and perception of a service on those dimensions.

Despite SERVQUAL's wide usage by academics and practicing managers in various industries (retailers, information systems, higher education, medical professionals, hotel and restaurants, airlines, tourism, etc.) and across different countries, a number of studies have questioned the conceptual and operational base of

the model. More specifically, these studies have failed to confirm the five-dimension structure across different industries (Babakus and Boller, 1992; Carman, 1990).

### **2.3.2. Development of SERVQUAL**

In 1991, Parasuraman et al. made some improvements to the 1988 SERVQUAL scales according to the recommendation of Carman, Babakus and Boller (Kettinger and Lee, 1994). They asserted that problems created by using negatively worded items should be resolved. Slightly modified to apply to Information System (IS) setting, the 1991 SERVQUAL instrument consists of two sections (Jiang et al., 2000). Section I measures the user's expected service level, and Section II measures the user's perceived service level. Resulting gap scores are produced by subtracting the 22 expected items in Section I from the 22 perceived items in Section II. No addition or deletion of items was made to the 1991 instrument.

In an empirical study, Cronin and Taylor (1992) showed stronger predictive validity for a version of the 22-item SERVQUAL instrument using only perceived service quality performance, as opposed to the SERVQUAL's gap scores of expectations minus perceived performance. According to their argument, Parasuraman et al. (1994) stated that superior predictive power of the performance-only measure must be balanced against its inferior diagnostic value to the practitioners.

While versions of SERVQUAL continue to be critiqued, SERVQUAL has become the preeminent instrument in the assessment of perceived service quality within marketing practice and research.

Recognizing the need to more comprehensively measure information services quality, Kettinger and Lee (1994) adapted the SERVQUAL instrument to the IS context as an enhancement to the existing User Information Satisfaction (UIS)

measure (Ives et al., 1983). They suggested that the original USISF (User Satisfaction with the Information in Service Function) may not be comprehensive enough to capture the more detailed dimensions of IS service quality in SERVQUAL, revealing that the reliability and empathy dimensions of IS service quality may need to supplement the service dimensions of USISF. In their article, Kettinger and Lee (1994) discussed SERVQUAL's theoretical roots in the quality and consumer satisfaction literature and focused on the practical value of the instrument's flexibility in the IS service context. Kettinger and Lee's (1994) study helped pioneer the use of the SERVQUAL instrument in the IS context. In their paper, using business students as subjects, they explored the dimensionality and validity of the instrument. Kettinger and Lee found support for four dimensions and a significant negative correlation between the perceived quality gap and UIS. In the five dimensions in the SERVQUAL instrument, they found reliability, responsiveness, assurance and empathy to be present. The tangibles dimension was missing. To further cross-validate the SERVQUAL instrument, student samples from Korea, Hong Kong, and the Netherlands were served to replicate the results found earlier (Kettinger and Lee, 1995). The same four dimensions were found in the Netherlands sample, but not in the Korea or Hong Kong samples.

Pitt et al. (1995) further extended the application of SERVQUAL in IS by placing service quality within the IS Success Model (Delone and McLean, 1992) and by independently testing SERVQUAL's reliability and validity in samples from three different organizations. The strength of the IS-adapted SERVQUAL instrument was then examined cross-culturally, using organizations in four different countries (Kettinger and Lee, 1995). In these introductory papers, the conceptual emphasis placed on service quality within the extent of past IS evaluation research and the

empirical focus was primarily on the determinations of IS-adapted SERVQUAL dimensionality. These articles only briefly touched on questions related to the use of “gap” scores and the potential problems in the SERVQUAL “expectation” measure (Kettinger and Lee, 1997).

In their study, Pitt et al. (1995) independently analyzed SERVQUAL data from three different sample sites using principal components and maximum likelihood methods with orthogonal rotation deriving three, five and seven factor solutions, respectively. In the seven-factor solution, the tangibles and empathy dimensions both split into two additional factors with reliability, responsiveness, and assurance dimensions remaining close to the original SERVQUAL dimensions. The factor solutions for the other two samples did not load clearly, nor closely resemble the original five SERVQUAL dimensions. Given their findings, Pitt et al. (1995) reported that “SERVQUAL does not clearly delineate among the dimensions of service quality”. They warned users of the 22-item IS-adapted SERVQUAL instrument to be aware of the coalignment of the dimensions of responsiveness, assurance, and empathy due to the semantic similarity of these concepts and indicated that the reliability of the tangibles dimension was low.

### **2.3.3. Some Cautions on the Use of SERVQUAL**

The difficulties associated with the SERVQUAL measure that are identified in the literature can be grouped in five main categories:

1. The use of difference or gap scores;
2. Poor predictive and convergent validity;
3. The ambiguous definition of the “expectations” construct;
4. Unstable dimensionality; and



5. Failure to capture the dynamics of changing expectations.

#### 2.3.3.1. Problems with the Use of Difference or Gap Scores

A difference score is created by subtracting one measure from another to create a third measure to get a distinct construct. For example, in scoring the SERVQUAL instrument, the expectations score is subtracted from the perceptions score to create such a gap measure of service quality. Several problems with the use of difference scores make them a poor choice as measures of psychological constructs. The described difficulties related to the use of difference measures include low reliability, poor discriminant validity, spurious correlations, and variance restrictions.

#### 2.3.3.2. Reliability Problems with Gap

Many studies demonstrate that Cronbach's (1951) alpha, a widely used method of estimating reliability, is inappropriate for difference scores (Van Dyke et al., 1999). This is because the reliability of a difference score is dependent on the reliability of the component scores and the correlation between them. As the correlation of the component scores increases, the reliability of the difference scores decreases. Therefore, Cronbach's alpha tends to overestimate the reliability of the difference scores when the component scores are highly correlated. Such is the case of the SERVQUAL instrument (Peter et al., 1993).

#### 2.3.3.3. Validity Issues

Another problem with the SERVQUAL instrument concerns the poor predictive and convergent validities of the measure. Babakus and Boller (1992) reported that perceptions-only SERVQUAL scores had higher correlations with an

overall service quality measure and complaint resolution scores than the perception-minus-expectation scores typically used by SERVQUAL. Parasuraman et al. (1991) reported that the SERVQUAL perception-only scores produced higher adjusted  $R^2$  values (ranging from .72 to .81) compared to the SERVQUAL gap scores (ranging from .51 to .71) for each of the five dimensions. Brelsinger and Lambert (1990) found the evidence of the poor predictive validity of SERVQUAL, while Cronin and Taylor (1992, 1994) confirmed the superior predictive and convergent validity of the perception-only scores. Their results indicated higher adjusted  $R^2$  values for perception-only scores across four different industries. The perception component of the perception-minus-expectation scores performs better as a predictor of the perceived overall quality than the difference score itself (Parasuraman et al., 1988; Cronin and Taylor, 1992, 1994; Babakus and Boller, 1992; Boulding et al., 1993).

#### 2.3.3.4. Ambiguity of the “Expectations” Construct

Teas (1994) noted that SERVQUAL expectations have been variously defined as desires, wants, what a service provider should possess, normative expectations, ideal standards, desired service, and the level of service a customer hopes to receive (e.g., Parasuraman et al. 1988, 1991, 1994; Zeithaml et al. 1993). These multiple definitions and corresponding operationalizations of “expectations” in the SERVQUAL literature has resulted in a concept that is loosely defined and open to multiple interpretations (Teas, 1994). Different interpretations of “expectations” include a forecast or prediction, a measure of attribute importance, a classic ideal point, and a vector attribute (Teas, 1993; Parasuraman et al., 1994). These various interpretations can result in potentially serious measurement validity problems. For example, the classic ideal point interpretation results in an inverse of the relationship

between SERVQUAL calculated as perceptions minus expectations ( $P - E$ ) and perceived SERVQUAL ( $P$  only), for all values when perception scores are greater than expectation scores (i.e.,  $P > E$ ).

#### 2.3.3.5. Unstable Dimensionality

The results of several studies (Babakus and Boller, 1992; Finn and Lamb, 1991; Carman, 1990; Cronin and Taylor, 1992; Parasuraman et al., 1991) have demonstrated that the five dimensions claimed for the SERVQUAL instrument are unstable. The unstable dimensionality of SERVQUAL, demonstrated in many domains including information services, is not just a statistical curiosity.

SERVQUAL replications, carried out in different service activities, show that the number of dimensions of the scale is not unique. For instance, Finn and Lamb (1991) found out that the dimensions change when customers estimate “product” services (department stores) instead of “pure” services (banks). The number of dimensions, found in the different replications and studied in this article, varies much (Babakus and Boller, 1992; Finn and Lamb 1991; Carman, 1990; Cronin and Taylor, 1992; Parasuraman et al., 1991). It is noted that the tangibles dimension is found in all of these replications. Cronin and Taylor (1992, 1994) considered SERVQUAL as “unidimensional” because they do not confirm the scale structure.

In 1992, through factor analysis, McDougall and Levesque (Llosa et al., 1998) found the three following dimensions: Tangibles, Contract Performance and Customer-Staff Relationship. Perfecting their analysis by measuring the respective importance of these three dimensions, they noted that the first one obtained only ten points among the one hundred to be spread. They concluded that: Perceived service quality has two main facets, one representing the output quality, the other the service

process. More generally, measuring expectations with a Likert scale overestimates the importance of certain dimensions (“Tangibles” in this study), for respondents do not have to make comparative judgment between the different dimensions of the scale.

#### 2.3.3.6. The Dynamics of Changing Expectations

Some criticisms point out that SERVQUAL fails to capture the dynamics of changing expectations. Customers learn from experiences. Users may adjust or raise their expectations based on what they experience from previous service encounters. The customer service life cycle breaks down the service relationship with a customer into four major phases: requirements, acquisitions, stewardship, and retirement. In general, user’s expectations differ among these phases (Pitt et al., 1995). Wotruba and Tyagi (1991) suggested that how expectations are formed and changed over time should be taken into consideration in future work. Gronroos (1993) advocated focusing on the dynamics of service quality evaluation.

### 2.3.4. Some Alternatives to SERVQUAL

#### 2.3.4.1. SERVPERF

SERVPERF is a performance-based measure of service quality, which uses only a direct measure of perception to capture the discrepancy between expected and perceived service quality. The reason for introducing SERVPERF is twofold.

Firstly, based on the work by marketing researchers that advocate direct perceptual measures instead of gap scores (Brown et al. 1993; Cronin and Taylor, 1992, 1994), they contended that one’s perception of service quality already entails an expected service. By separately measuring the expected and perceived level of service quality and subtracting these scores, they argued, SERVQUAL is too simplistic to

measure this complex cognitive evaluation process. Second, Van Dyke et al. (1997) argued that SERVQUAL's expectation construct is ambiguous. Based on the work of Teas (1993) and Boulding et al. (1993), they stated that the expectation measures suffer from multiple interpretations depending on whether a customer bases his/her assessment on a prediction of what would occur in the next IS service encounter or on what ideally should occur. To partially avoid the problem of an ambiguous expectation measure, researchers (e.g., Teas, 1993; Peter et al., 1993) argued for a direct single-item comparative measure of the perception-expectation gap.

Van Dyke et al. (1997) proposed that the predictive power of the IS-adapted SERVPERF instrument is superior to the IS-adapted SERVQUAL. Other comparative criteria, such as reliability and convergent and discriminant validity, showed that the IS-adapted SERVPERF provided either weak or unsubstantial improvement over SERVQUAL. This finding is consistent with empirical evidence from marketing, where they have not conclusively established that SERVPERF is superior in terms of convergent or discriminant validity (Parasuraman et al. 1993, 1994).

Assuming that the findings from Kettinger and Lee (1997) and Pitt et al. (1995) are correct, IS managers might question: Why should we use SERVQUAL, which requires double the number of items, if SERVQUAL has no better psychometric properties than SERVPERF? In fact, Parasuraman et al. (1994) and Pitt et al. (1995) addressed this question by suggesting that the richer information contained in SERVQUAL's disconfirmation-based measurements provides managers with diagnostic power that typically outweighs the statistical and convenience benefits derived from the use of SERVPERF. Parasuraman et al. (1994) asked, "Are managers who use service quality measurements more interested in accurately identifying service shortfalls or explaining variance in an overall measure of perceived service

quality?” Ultimately, managers must decide based on their own unique needs whether SERVQUAL’s superior diagnostic value is preferable to SERVPERF’s convenience.

#### 2.3.4.2. SERVQUAL+

Parasuraman et al. (1994) proposed and tested three alternative service quality measures. SERVQUAL+ was one of them, which has a three-column format generating separate ratings of desired, adequate, and perceived service with three identical and side-by-side scales (showed in Table 2.1). This model uses the concept of tolerance, which has the potential to overcome many of the complaints waged by Van Dyke et al. concerning the ambiguity of the IS-adapted SERVQUAL gap measure (Kettinger and Lee, 1997).

Table 2.1. SERVQUAL+ formats (adapted from Parasuraman et al., 1994)

##### Three Column Format (SERVQUAL+)

My Minimum Service Level is:	My Desired Service Level is:	My Perception of ___’s Service Performance is:
Low                      High	Low                      High	Low                      High
1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9

In this model, Zeithaml et al. (1993) pointed out that service expectations exist at two levels that customers can use as standards in assessing service quality, namely, desired service and adequate service. The former represents a level of service what customers are expecting, while the latter is the minimum level of service customers are willing to accept. These two levels establish a range of service performance customer would consider satisfactory. Therefore, rather than a single expectation point, customer service expectations are characterized by a range of levels. This “desired” expectation, “adequate” expectation, and “perceived” service format has a

strong practitioner appeal. Service providers may formulate service improvement plans based on this zone of tolerance concept. Depending on the relative position of the perceived service pointer (within or outside of the zone) for each of the different dimensions, short-term and long-term quality improvement resource allocation plans can be prescribed. In the short term, any dimension with a perceived pointer outside of the zone would be a service dimension requiring utmost attention. When all of the pointers are within the zones, the relative positioning of any pointer and the width of the zone itself are the criteria for deriving long-term service improvement plans.

Further testing of these scales and the adaptation of the promising SERVQUAL+ instrument will, most probably, result in an improved instrumentation that possesses better psychometric and practical properties than the current versions of SERVQUAL, SERVQUAL short form and SERVPERF (Kettinger and Lee, 1997). However, until researchers deliver these improved measures, most of the managers are like to choose the service quality instrument that best satisfies their unique measurement context.

#### 2.3.4.3. The Concept of Loss

Since SERVQUAL's introduction in 1988, both theoretical and operational criticisms have constantly appeared. There is one substantial criticism on the operation of SERVQUAL instrument. Classical SERVQUAL use the assumption that the positive and negative disconfirmations are symmetrically weighted. However, from customers' viewpoint, failure to meet expectations often seems to be a more significant outcome than success in meeting or exceeding expectations (Hardie et al., 1993). In situations where the disconfirmation gaps take different signs, the averaging

process may not be an optimum way of aggregating service quality data (Hussey, 1999).

Therefore Hussey proposed the notion of SERVQUAL loss and introduced Categorical, Linear and Quadratic loss functions. The details of the three loss functions are as follows:

First, the categorical measure of service quality loss simply computes the proportion or percentage of SERVQUAL question pairs that are negative gaps. Zero or positive discomfiture gaps are scored together as zero to indicate that the respondent experiences no regret or loss with the feature described by the question pair under consideration. Not only will this measure be easily understood, it also provides an index of satisfaction for service quality performance.

Second, the linear measure of SERVQUAL quality loss function is computed simply by setting all positive discomfiture gaps to zero, reversing the sign of the negative gaps and then averaging the results. The linear function is closely associated with the original SERVQUAL function. If all of the discomfiture gaps are less than zero, then the linear service quality loss score will be equal to the standard SERVQUAL score but with reversed sign.

Third, the quadratic loss function sets positive gap scores to zero. Negative gap readings are squared to amplify their effect and making their sign positive. This measure will clearly identify the suppliers, which the customers feel most unsatisfying.

However, Hussey found out in his tests that using a single measure of overall service quality is over simplistic. What may be more useful is the richer profile of customer service quality provided by several different measures. Given that linear loss is closely related to classical SERVQUAL when most gaps are negative, it is perhaps best to construct an overall profile using all the categorical, linear and quadratic



measures. Future research priorities include the determination of accurate significance levels for the three different loss statistics. Hussey suggested that Monte Carlo methods would be needed to evaluate the appropriate significance levels for the linear and quadratic loss measures.

## **2.4. Conclusions**

As the above literature review shows, the originations and developments of QFD and SERVQUAL are briefly introduced. The basic frameworks of how to practically apply QFD and SERVQUAL are demonstrated, that is, the most common used matrix - HOQ and the backbone of QFD - VOC in QFD applications and the 22-item instrument using gap scores of expectations minus perceived performance in SERVQUAL applications. Although many empirical studies have been carried out, accommodation services and distance learning are relatively not explored. Two case studies based on these two areas are reported in this study. Besides, This literature survey also revealed many limitations of the existing QFD and SERVQUAL models. Especially, the unstable dimensionality and ambiguity of input in the SERVQUAL model are the main motivations for this research to carry out.

However, due to the constraints of resource and time, it will be impossible to investigate all the limitations and problems identified in the above literature review. Therefore, many potential research topics will not be covered in the current study. The main theme of this study will be on the three research objectives as mentioned in Chapter 1.

## **Chapter 3**

# **Employing Fuzzy Set Theory with SERVQUAL to Evaluate Service Quality**

### **3.1. Motivation for Employing Fuzzy Set Theory**

Service industries are becoming more and more important in the worldwide economy. Improving service quality effectively has become the main issue for business managers. There are a number of definitions of service quality. One definition based on customer satisfaction can be defined commonly by comparing perceptions of service with expectations of service. However, services have many characteristics that make the evaluation of quality much more difficult than commodities, like intangibility, heterogeneity, subjection, customer participation and perishability. Intangible attributes of service quality, such as safety and comfort, are difficult to measure accurately. Besides, different individuals usually have a wide range of perceptions toward quality service, depending on their preference structures and roles in process (Tsaur et al., 2002). Therefore, measuring service quality is one of the greatest challenges for every organization since many intangible factors and the customers' subjective judgments can influence customer satisfaction.

To measure service quality, conventional measurement tools are devised on cardinal or ordinal scales. L-point of Likert scale is the major way to evaluate service quality in the past. The Likert technique presents a set of attitude statements. Subjects are asked to express agreement or disagreement of a L-point scale. For example, 5-

point Likert scale asks to give each degree of agreement a numerical value from 1 to 5. In these investigations, the customers usually use crisp values to represent their feelings and subjective perception of service quality. Most of the criticisms about scales based on measurement are that scores do not necessarily represent user preference. In fact, due to intangible and subjective information often appearing in the evaluation process, crisp values are inadequate to represent the evaluation ratings of customers. This is because respondents have to internally convert preferences to scores and the conversion may introduce distortion of the captured preferences (Tsaour et al., 2002), forcing the evaluators to do an over-high or over-low appraisal. Consequently, it would influence the accuracy of the evaluation.

To reduce the subjectivity and ambiguity for the judgment of service quality by each customer, the fuzzy approach is better than the traditional statistic approach. In other words, a more realistic way may be to use linguistic assessments instead of numerical values. Modeling using fuzzy sets has proven to be an effective way for formulating decision problems where the information available is subjective and imprecise (Zimmermann, 1996; Hellendoorn, 1997; Chang and Yeh, 2002). A set of scale of linguistic labels can be presented to the customers, who can use it to describe their opinions.

### **3.2. Fuzzy Set Theory and its Applications**

Fuzzy set theory was developed for solving problems in which descriptions of activities and observations are imprecise, vague and uncertain. Lingual expressions, for example, satisfied, fair and dissatisfied, are regarded as the natural representations of the preference or judgment. These characteristics indicate the applicability of fuzzy set theory in capturing the decision makers' preference structure. Fuzzy set theory

aids in measuring the ambiguity of concepts that are associated with the human being's subjective judgment. Since the evaluation is resulted from different evaluator's view of linguistic variables, it must be conducted in an uncertain fuzzy environment. During the process, evaluators are imprecise with a significant large allowance for error. However, from the decision makers' point of view, it will be easier for them to utilize quantitative rather than qualitative information. Therefore, to treat the vagueness and ambiguity inherent in the linguistic input and to make the decision-making process workable, it will be better to employ fuzzy set theory in the process to apply SERVQUAL.

"Not very clear", "probably so", and "very likely", these terms of expression can be heard very often in daily life, and their commonality is that they are more or less tainted with uncertainty. With different daily decision-making problems of diverse intensity, the results can be misleading if the fuzziness of human decision-making is not taken into account. However, since Zadeh (1965) first proposed fuzzy set theory and Bellman and Zadeh (1970) described the decision-making method in fuzzy environments, an increasing number of studies have dealt with uncertain problems by applying fuzzy set theory. In addition, when implementing SERVQUAL with linguistic data, some factors may affect the results, such as the type of fuzzy numbers, defuzzification strategies, and the degree of fuzziness of fuzzy numbers.

Nowadays, the fuzzy set theory has been applied to the field of management science, like decision making (Hutchinson, 1981; Viswanathan, 1999; Xia et al., 2000; Chen, 2001), and in the implementation of QFD (Masud and Dean, 1993; Bahrami, 1994; Khoo and Ho, 1996; Fung et al., 1998). The fuzzy set theory was also used in evaluating service quality, especially integrated with Multicriteria Decision Making (MCDM) process (Tsaur et al., 2002; Chien and Tsai, 2000; Chen, 2001).

### 3.3. Linguistic Variable

A linguistic variable differs from a numerical variable in that its values are not numbers but words or phrases in some languages (Zadeh, 1975). It is a variable with lingual expression as its values. One example for the linguistic variable is “bus service quality”. It means the service quality that passengers experience during traveling in a bus. The possible values for this variable could be: “very dissatisfied”, “not satisfied”, “fair”, “satisfied”, and “very satisfied”.

### 3.4. Fuzzy Number and Fuzzy Arithmetic

Let the universe of discourse  $X$  be the subset of real numbers  $R$ ,  $X = \{x_1, x_2, x_3, \dots, x_n\}$ . A fuzzy set  $\tilde{A} = \{(x, \mu_A(x)) \mid x \in X\}$  in  $X$  is a set of ordered pairs where  $\mu_A(x)$  is called a membership function and  $\mu_A(x): X \rightarrow [0,1]$ .

Definition 3.1. Let  $\tilde{A} = \{(x, \mu_A(x)) \mid x \in X\}$  and  $\tilde{B} = \{(x, \mu_B(x)) \mid x \in X\}$  (Klir and Yuan, 1995)

$$\mu_{A \cap B}(x) = \min(\mu_A(x); \mu_B(x)), x \in X$$

$$\mu_{A \cup B}(x) = \max(\mu_A(x); \mu_B(x)), x \in X$$

Definition 3.2. The  $\alpha$ -cut set  $\tilde{A}_\alpha$  of a fuzzy set  $\tilde{A}$  is defined as  $\tilde{A}_\alpha = \{x \mid \mu_A(x) \geq \alpha, x \in X\}$ ,  $0 \leq \alpha \leq 1$ ,  $\alpha \in R$  (Zimmermann, 1986). (see Fig. 3.1)

Definition 3.3. The Hamming Distance  $d(\mu_A(x); \mu_B(x)) = \int_x |\mu_A(x) - \mu_B(x)| dx$  (Klir and Yuan, 1995),

where  $\mu_A(x)$  and  $\mu_B(x)$  denote the membership functions of the triangular fuzzy numbers  $\tilde{A}$  and  $\tilde{B}$ , individually.

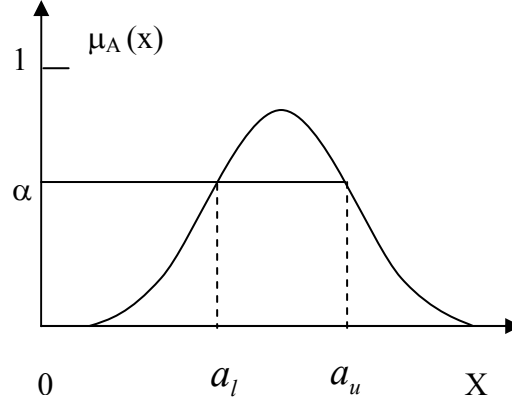


Fig. 3.1. The  $\alpha$ -cut set  $\tilde{A}_\alpha$  of a normal and convex fuzzy number  $\tilde{A}$

This section parameterizes a triangular fuzzy number  $\tilde{A}$  by the triplet  $(a_1, a_2, a_3)$ . The membership function  $\mu_A(x)$  of  $\tilde{A}$  is defined in Eq. (3.1), and its graph is shown in Fig. 3.2.

$$\mu_A(x) = \begin{cases} y_a^L(x) = \frac{x - a_1}{a_2 - a_1}, & a_1 \leq x \leq a_2 \\ y_a^R(x) = \frac{x - a_3}{a_2 - a_3}, & a_2 \leq x \leq a_3 \\ 0, & \text{otherwise.} \end{cases} \quad (3.1)$$

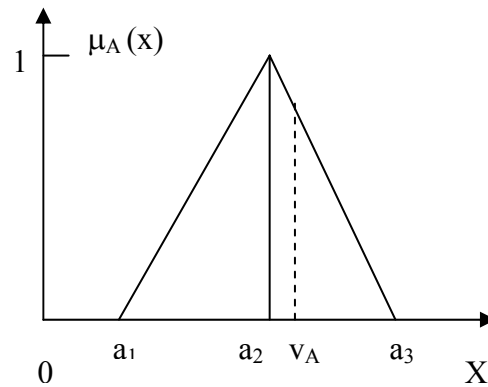


Fig. 3.2. A triangular fuzzy number  $\tilde{A}$

In Fig. 3.2,  $v_A$  is a point that divides the bounded area of a triangular fuzzy number  $\tilde{A}$  into two equal parts.

Linguistic terms, satisfaction degree and importance degree, are often vague. To provide more objective information, we fuzzify satisfaction degree and importance degree as triangular fuzzy numbers individually by Eq. (3.1), and apply Eq. (3.2) to aggregate group opinions.

Aave in Eq. (3.2) denotes the average fuzzy number of  $n$  triangular numbers  $\tilde{A}_i = (a_1^{(i)}, a_2^{(i)}, a_3^{(i)})$ , where  $i = 1, 2, 3, \dots, n$ . Without loss of generality,  $\tilde{A}$  replaces Aave. To justify whether an attribute is weak or strong, we compare  $v_A$  between two triangular fuzzy numbers that are defined in Eq. (3.3) (Chen, 1996).

$$\tilde{A} = \text{Aave} = \frac{\tilde{A}_1 + \tilde{A}_2 + \dots + \tilde{A}_n}{n} = \frac{(\sum_{i=1}^n a_1^{(i)}, \sum_{i=1}^n a_2^{(i)}, \sum_{i=1}^n a_3^{(i)})}{n} = (a_1, a_2, a_3) \quad (3.2)$$

$$v_A = (a_1 + 2a_2 + a_3)/4 \quad (3.3)$$

for the triplet  $(a_1, a_2, a_3)$  of a triangular fuzzy number  $\tilde{A}$ .

In the following section, Eq. (3.3) is applied to rank two fuzzy numbers for clarifying weak and strong attributes.

### 3.5. A Process Model for SERVQUAL Based on Linguistic Variables

In this section, a new method of measuring service quality is proposed, which is based on linguistic variables. Here, this process model is divided into the following four steps.

Step 1: Creating a triangular fuzzy number for the  $i$ th customer's linguistic terms.

Let  $\tilde{A}_i^k$  be a triangular fuzzy number that is the  $i$ th customer's linguistic importance degree, and let  $\tilde{B}_i^k$  be one that is the  $i$ th customer's linguistic satisfaction where  $k$  denotes the  $k$ th attribute,  $i = 1, 2, 3, \dots, n$ ,  $k = 1, 2, 3, \dots, p$ ,  $n$  is the sample size, and  $p$  represents the number of attributes.

To simplify mathematical symbols, we replace  $\tilde{A}_i^k$  by  $\tilde{A}_i$  and  $\tilde{B}_i^k$  by  $\tilde{B}_i$ , which represent the  $i$ th customer's importance degree and satisfaction degree for an attribute individually.

The triplets  $(0, 0, 2)$ ,  $(0, 2, 4)$ ,  $(2, 4, 6)$ ,  $(4, 6, 8)$ , and  $(6, 8, 8)$  of  $\tilde{A}_i$  for  $i = 1, 2, 3, \dots, n$ , in linguistic terms, mean “very unimportant”, “unimportant”, “fair”, “important”, and “very important”, respectively (see Fig. 3.3). Similarly, the triplets  $(0, 0, 2)$ ,  $(0, 2, 4)$ ,  $(2, 4, 6)$ ,  $(4, 6, 8)$ , and  $(6, 8, 8)$  of  $\tilde{B}_i$  for  $i = 1, 2, 3, \dots, n$  represent “very poor”, “poor”, “fair”, “good”, and “excellent” (see Fig. 3.4).

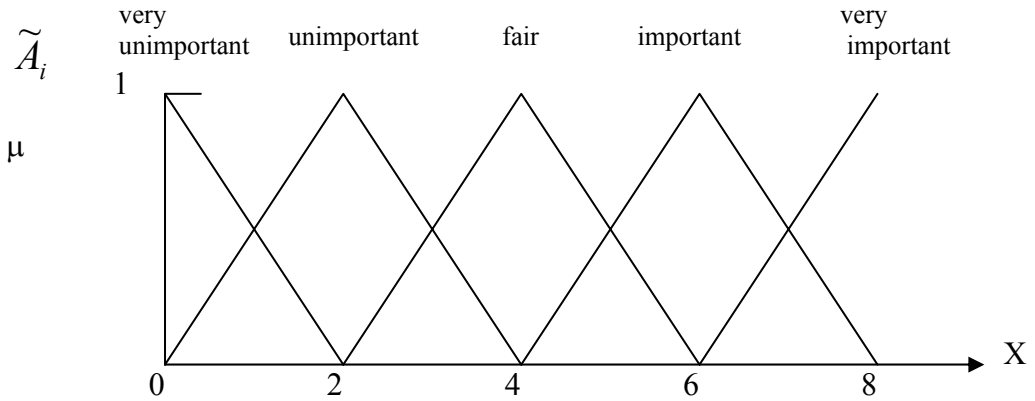


Fig. 3.3. The  $i$ th customer's linguistic importance term.



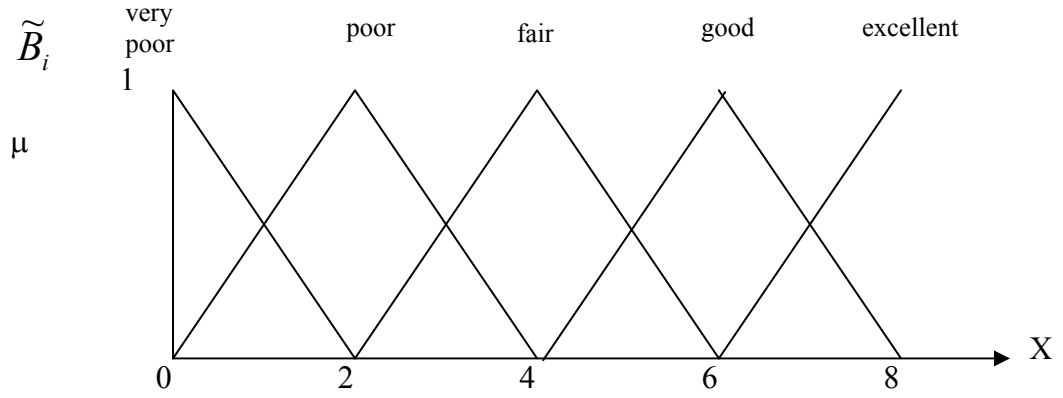


Fig. 3.4. The  $i$ th customer's linguistic satisfaction term.

Step 2: Creating an average triangular fuzzy number from  $n$  triangular fuzzy numbers.

Suppose  $\tilde{A}_i = (a_1^{(i)}, a_2^{(i)}, a_3^{(i)})$  and  $\tilde{B}_i = (b_1^{(i)}, b_2^{(i)}, b_3^{(i)})$  where  $i = 1, 2, 3, \dots, n$ .

We apply Eq. (3.2) to combine  $n$  customers' opinions, and define  $\tilde{A}$  and  $\tilde{B}$  in Eqs. (3.4) and (3.5) that are the average triangular fuzzy numbers of  $\tilde{A}_i$  and  $\tilde{B}_i$  respectively, where  $i = 1, 2, 3, \dots, n$ .

$$\tilde{A} = A_{ave} = \frac{\tilde{A}_1 + \tilde{A}_2 + \dots + \tilde{A}_n}{n} = \frac{(\sum_{i=1}^n a_1^{(i)}, \sum_{i=1}^n a_2^{(i)}, \sum_{i=1}^n a_3^{(i)})}{n} = (a_1, a_2, a_3) \quad (3.4)$$

$$\tilde{B} = B_{ave} = \frac{\tilde{B}_1 + \tilde{B}_2 + \dots + \tilde{B}_n}{n} = \frac{(\sum_{i=1}^n b_1^{(i)}, \sum_{i=1}^n b_2^{(i)}, \sum_{i=1}^n b_3^{(i)})}{n} = (b_1, b_2, b_3) \quad (3.5)$$

Step 3: Clarifying the weak or strong attributes.

If customers' satisfaction degree is greater than importance degree for an attribute, then we consider the attribute is strong. Otherwise, it is weak.

To clarify which attribute is weak or strong objectively, it is important to differentiate whether the discrepancy between satisfaction degree and importance

degree is positive or negative. Instead of the averages of difference scores, we apply Eq. (3.3) to justify which attribute is preferable.

With respect to an attribute, let  $\tilde{A} = (a_1, a_2, a_3)$  be the average triangular fuzzy number of importance degree, and  $\tilde{B} = (b_1, b_2, b_3)$  be the one of satisfaction degree. Applying Eq. (3.3),  $\tilde{A}$  constructs  $v_A$  in Eq. (3.6) and  $\tilde{B}$  gives  $v_B$  in Eq. (3.7). Therefore, if  $v > 0$  in Eq. (3.8), the attribute is considered as a strong one; otherwise, it is a weak one.

$$v_A = (a_1 + 2a_2 + a_3)/4 \quad (3.6)$$

$$v_B = (b_1 + 2b_2 + b_3)/4 \quad (3.7)$$

$$v = v_B - v_A \quad (3.8)$$

To clarify an attribute from “v” of Eq. (3.8), three conditions are illustrated in the following:

1. If  $v < 0$  that indicates  $v_B < v_A$ , we say the attribute is weak because customers' satisfaction degree is less than importance degree. Therefore, the attribute is under an inferior condition.
2. If  $v > 0$  that indicates  $v_B > v_A$ , we consider an attribute is strong because customers' satisfaction degree is more than importance degree. In other words, the attribute is under an advantageous condition.
3. If  $v = 0$  that implies  $v_B = v_A$ , then the attribute resource is used sufficiently because customers' satisfaction degree exactly equals importance degree. However, this case is rare.

Step 4: Defuzzification.

The result of fuzzy synthetic decision of each alternative is a fuzzy number. Therefore, it is necessary that the nonfuzzy ranking method for fuzzy numbers is

employed during service quality comparison for each alternative. In other words, defuzzification is a technique to convert the fuzzy numbers into crisp real numbers. The procedure of defuzzification is to locate the Best Nonfuzzy Performance (BNP) value. There are several available methods that serve this purpose. Mean-of-Maximum, Center-of-Area, and  $\alpha$ -cut Method are the most common approaches (Zhao and Govind, 1991). This study utilizes the Center-of-Area method due to its simplicity and no requirement for the analyst's personal judgment.

The defuzzified value of a triangular fuzzy number can be obtained from Eq. (3.9).

$$BNP = ((a_3 - a_1) + (a_2 - a_1))/3 + a_1 \quad (3.9)$$

The above is a process model only based on simple computerizations of fuzzy numbers. We could induce general solutions for the intersection area between two triangular fuzzy numbers, so that the discrepancy rate “r” between satisfaction degree and importance degree can be found. We also can consider (1-r) which is called “compatibility” between perceived service and expected service. As suggested in Dubois and Prade (1988), the attractiveness of a fuzzy attribute (satisfaction degree,  $\mu_B(x)$ ) relative to a fuzzy objective function (importance degree,  $\mu_A(x)$ ) may be evaluated as the compatibility between two fuzzy sets. Let  $\Pi(\mu_A(x), \mu_B(x))$  be the possibility that an attribute fits the customer objective.  $N(\mu_A(x), \mu_B(x))$  measures the certitude of  $\mu_A(x)$  relative to  $\mu_B(x)$ , as a degree to which the statement “the attribute does not fit the customer objective” is impossible.

### 3.6. Conclusion

As services have many characteristics such as intangibility, heterogeneity, perishability, and subjection, which make the evaluation of service quality influenced

by many uncertain factors. Fuzzy set theory was developed for solving problems in which descriptions of activities and observations are imprecise, vague and uncertain. In this chapter, we attempt to propose a fuzzy approach to reduce the ambiguity and the subjectivity in the measurement of service quality.

First, the concept of a linguistic variable, fuzzy number and fuzzy arithmetic are briefly introduced. Second, to employ the fuzzy set theory with SERVQUAL, a process model based on triangular fuzzy numbers is proposed in this chapter, which includes four steps: “Creating a triangular fuzzy number for the  $i$ th customer’s linguistic terms”, “Creating an average triangular fuzzy number from  $n$  triangular fuzzy numbers”, “Clarifying the weak or strong attributes” and “Defuzzification”. Specifically, we use  $v$ -value to clarify the weak or strong attributes and Center-of-Area method to locate the BNP value in this model.

This proposed fuzzy approach allows SERVQUAL users to avoid the subjective and arbitrary quantification of linguistic data and presents a framework that is easy to use during the evaluation of service quality by SERVQUAL.

# **Chapter 4**

## **Using QFD to Evaluate Service Quality in Accommodation Services by the National University of Singapore**

### **4.1. Introduction**

Nowadays, colleges and universities are increasingly finding themselves in a fiercely competitive environment. Today's students expect that colleges and universities have what they also demand elsewhere: better service, lower costs, higher quality, and a mix of products that satisfy their own sense of what a good education ought to provide. The recent inclusion of education organizations as a new category in the Malcolm Balridge National Quality Award (MBNQA) affirms the increasing importance of quality assurance in education.

Competition among universities are increasing due to reasons like changing student demographics, diminishing government funding, and high requirement of employers, etc. What's more, many nations have shown a trend of economy recession recently. The declining economy has apparent influences on higher education in two aspects: One aspect is the decrease in fund allocation by government and enterprises, and the other is the stricter requirements of the employers. On the other hand, the prospective students also pay more attention to the overall quality of the universities.

Total Quality Management (TQM) was introduced to achieve a quality education for many years. Many TQM principles and tools used by the industries are now being applied to an educational setting. The Japanese-developed Quality Function Deployment, which has won recognition worldwide, has been successfully applied to higher education in many cases in the areas of research and teaching, such as research plan development, degree program design, teaching improvement, and curriculum change, etc. This chapter presents a case study of identifying and meeting students' needs of accommodation services, which also have a great influence on students' experiences in universities. Student accommodation is always considered one of the most important services during the higher education period. Not only will students spend more than eight hours a day in activities relating to accommodation, but accommodation can also be an important education base for students to develop their characters, to make friends, to practice their living abilities, to develop their communication skills, and to resolve their personal problems. As a result, if accommodation services meet students' needs well, they will be much more satisfied with their experiences in universities.

## **4.2. Applications of QFD in Higher Education**

QFD has been applied to improve higher education in recent years. At Aston University in the United Kingdom, the head of the Department of Vision Sciences formed a project team to test the applicability of QFD in the design and evaluation of a degree program (Clayton, 1993). It provided the department head with a framework for a detailed analysis of the efficiency of an existing program. Clayton also recommended that due to the nature of QFD, which starts from the needs of student,

the real power of QFD would be significant when used for an introduction of a new study program.

At West Virginia University in the United States, to increase enrollment and retain current students in engineering, QFD was applied to explore ways to improve the advising process as well as to improve the teaching process (Jaraiedi and Ritz 1994).

Another example is at Grand Valley State University in the United States (GVSU). Pitman et al. (1995) and Motwani et al. (1996) illustrated how QFD method had been used to measure customer satisfaction in educational institutions, and the MBA program at GVSU was evaluated. Through the use of three HOQs, the VOC was derived from the students and the business community. The results showed that QFD was successful in ascertaining customer desires, prioritizing them, and directing organizational resources towards customer satisfaction.

Krishnan and Houshmand (1993) applied QFD to the design of engineering curricula and showed how it can be implemented in a university setting at the University of Cincinnati.

To strengthen the research program of the Department of Industrial Engineering at Mississippi State University, QFD was developed to be a good means for formalizing the process of the strategic research planning (Chen and Bullington, 1993). QFD was used to help identify key customers for departmental research efforts, to identify and track their research needs, to fashion a comprehensive strategic plan for departmental research activities, to deploy various research functions and responsibilities and to track research performance relative to goals.

At the Department of Mechanical Engineering of the University of Wisconsin-Madison, QFD was also employed to revise the ME curriculum (Ermer, 1995). At the

start of a QFD effort, three categories of customers were identified: faculty members, undergraduate students, and future employers of the students. Thus three HOQs were constructed. They pointed out the needs to revise the undergraduate curriculum and to increase support and recognition of faculty members by the department chairman. The department's use of QFD provided a successful example of process improvement and cycle time reduction in an academic setting.

Lam and Zhao (1998) used both QFD and AHP to identify teaching methods and techniques, and to evaluate effectiveness in achieving educational objectives at the Department of Applied Statistics and Operational Research at the City University of Hong Kong. A QFD matrix was developed by employing ten educational objectives as the customer requirements and the teaching techniques as the technical specifications. The effectiveness ratings from QFD were used as the correlation between technical specifications and customer requirements. Through this process, the most effective teaching techniques were identified.

Recently, a three-phased adapted QFD model (service planning, service element planning, and operations planning) for a service environment was applied by Hwang and Teo (2000) in the business school at the National University of Singapore (NUS). HOQs were developed in three cases: the course design and delivery, the online course registration system, and the research grant application. Each case carried out a three-phased house-to-house translation to translate the VOC into concrete, actionable steps for service improvement in higher education.

Although QFD has been applied in higher education for years, the focus has been on research and teaching. Few efforts, however, has been made to improve the quality of education in other activities, like accommodation, enrollment, and



extracurricular activities. In view of this drawback, an application of QFD in another aspect in higher education, student accommodation services, is presented below.

### **4.3. Data Collection**

#### **4.3.1. Gathering the Voice of Students**

The first step in this case study is to identify the voice of students who are primary customers of the accommodation services provided by NUS. Two methods were firstly adopted to get the requirements of the students. Although the most effective method is one-to-one interview (Shillito, 1994; Cohen, 1995), emailing and posting onto newsgroup were firstly adopted because of the cost savings and fast execution.

However, after 50 emails were randomly sent out to ask the requirements of the students who were current customers of accommodation services in NUS, only four of them were replied. The response rate was quite low because the emails were not sent by the authorities. Moreover, the reply emails consisted very few contents. As it was hard and time-consuming to ask relevant authorities to urge students to reply emails, this method was abandoned. One-to-one interview method was taken as the primary method eventually. Although the interview method consumed much more time, it can provide a much deeper and more thorough understanding of the students' requirements. In total, 15 students including graduate and undergraduate students were interviewed to get a better understand of the different requirements of the students. These voices were classified into four categories: study, entertainment, living, and others. A list of user requirements of student accommodation services is presented in Table 4.1.

**4.3.2. Preparation of the Questionnaire**

After figuring out what students want and need from the accommodation services in NUS, it is interesting to understand the perception of the services. To focus on relative weak performances of these services, a paper-based survey was conducted.

Table 4.1. Categorized user requirements

Study	Provide a cozy study environment
	Convenient to access Internet
	Have effective rules to reduce noise
Entertainment	Easy to enjoy sports facilities
	Have plenty of activities for fun and communication
	Have various entertainment facilities nearby
Living	Access most parts of campus and city easily
	Availability of different kinds of food nearby
	Easy to buy living necessities even at late night
	Easy to access basic appliances (e.g., for cooking and laundry)
Others	Convenient to access medical services 24 hours a day
	Damaged facilities can be repaired on time
	Good security
	Availability of different types of room
	Can choose roommates/flatmates
	Easy to approach resident assistants in case of difficulties
	New and thorough accommodation services information on the website
	Availability of sufficient public telephones in the residences
	Availability of household cleanliness services
	Conveniently access ATMs

Based on the identified user requirements of the student accommodation services, a questionnaire was designed for surveying the perception value. First, the 20 user requirements were converted into 20 sentences during the design process. For instance, user need “provide a cozy study environment” was expressed as “ A cozy environment for studying is provided”. Besides, this questionnaire employed a 5-point scale (1 - strongly disagree, 2 - slightly disagree, 3 - neutral, 4 - slightly agree, 5 - strongly agree) to demonstrate the relative perception degree.

Finally, the questionnaire consists of two sections: respondents’ background questions and user requirement perception questions. The background questions asked the degree, the nationality, the residence lived in and the duration of living in the residences provided by NUS. These are four most possible customer segments. These segments are likely to affect the results in some degree.

#### **4.4. Data Analysis**

The questionnaire-based survey lasted for two weeks, because there are nine residences provided by NUS, eight is on-campus and one is off-campus. To confirm the questionnaires evenly covered all nine residences, each residence was reached individually to get students to complete this survey. A Total of 450 questionnaires were sent out, 433 replies were received and 401 of them were considered valid for analysis. Those replies with missing data were excluded. The response rate was near 90%, which was really high.

##### **4.4.1. Analysis of the Ranked Perception of User Requirement and Some Descriptive Statistics**

Some descriptive analyses were performed based on the data collected from

401 respondents. A list of user requirements with mean, standard deviation, and standard error of mean can be found in Table 4.2.

Table 4.2. Ranked perceptions of user requirements (descending) and some descriptive statistics

User Requirement	Ranking	Mean	Std. Deviation	Std. Error
Convenient to access internet	1	3.64	1.38	6.89E-02
Access most parts of campus and city easily	2	3.54	1.13	5.66E-02
Easy to access basic appliances	3	3.42	1.19	5.94E-02
Provide a cozy study environment	4	3.35	1.07	5.34E-02
Easy to enjoy sports facilities	5	3.28	1.33	6.64E-02
Availability of different kinds of food nearby	6	3.24	1.14	5.70E-02
Good security	7	3.21	1.21	6.02E-02
Have plenty of activities for fun and communication	8	3.21	1.31	6.52E-02
Easy to approach resident assistants in case of difficulties	9	3.11	1.03	5.14E-02
New and thorough accommodation services information on website	10	2.95	1.02	5.10E-02
Availability of different types of room	11	2.93	1.24	6.20E-02
Have effective rules to reduce noise	12	2.91	1.26	6.28E-02
Availability of household cleanliness services	13	2.91	1.25	6.22E-02
Have various entertainment facilities nearby	14	2.89	1.17	5.85E-02
Easy to buy living necessities even at late night	15	2.84	1.26	6.31E-02
Damaged facilities can be repaired on time	16	2.83	1.15	5.72E-02
Convenient to access medical services 24 hours a day	17	2.66	1.19	5.92E-02
Availability of sufficient public telephones in the residences	18	2.61	1.23	6.16E-02
Can choose roommates/flatmates	19	2.53	1.30	6.48E-02
Conveniently access ATMs	20	2.37	1.36	6.79E-02

Table 4.2 shows that the mean value of perceived performance ranges from 3.64 to 2.37, and about half of statements (11) are below 3.0. It presents that there are quite a lot of student accommodation services need improvements. The least three values are “Conveniently access ATMs” (2.37), “Can choose roommates/flatmates” (2.53), and “Availability of sufficient public telephones in the residences” (2.61). On the other hand, the three most satisfied items are “Convenient to access Internet” (3.64), “Access most parts of campus and city easily” (3.54), and “Easy to access basic appliances” (3.42).

Although the sample size is relatively large (401), the standard deviation of each item is larger than 1.0. The main reason is that there are obvious customer segments due to nine independent residences, including Prince George’s Park, Gillman Heights, Eusoff Hall, Kent Ridge Hall, KEV II Hall, Raffles Hall, Sheares Hall, Temasek Hall, and Kuok Foundation House and Extension Block A. Each residence has different location, internal decoration, and facilities. Among the nine residences, Gillman Heights is the most different from others, because it is the only one that is located off-campus, and it has no sports, entertainment, and canteen facilities. Above all, it also has no network points for direct Internet access, while other residences have.

#### **4.4.2. Category Comparison in Terms of Satisfaction and Importance**

As mentioned before, students’ needs and wants were sorted into four categories: study, entertainment, living and others. It is of interest to analyze the differences among the four categories in terms of both satisfaction ranking and importance ranking. The satisfaction and importance data of the four categories are presented in Figure 4.1. Each value is computed as the mean of the customer

responses for each question belonging to the same category. Figure 4.1 shows the differences exist among the four categories.

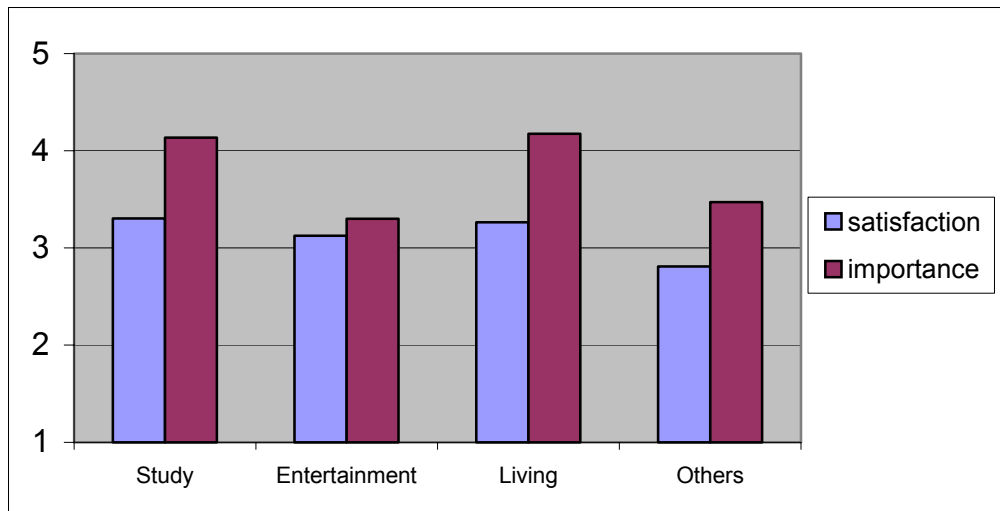


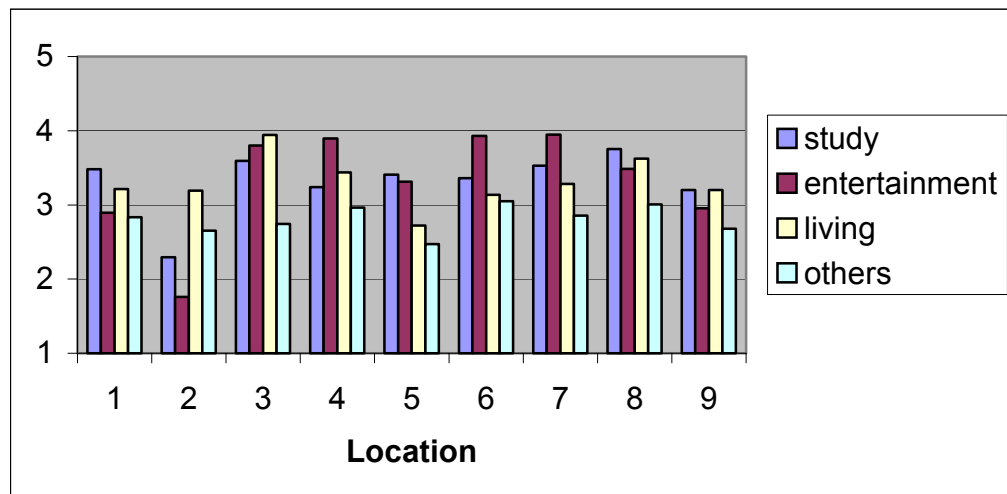
Figure 4.1. Category comparison in terms of satisfaction and importance

In the satisfaction dimension, namely the perception dimension, the average satisfaction degree of study ranked the highest among the four categories (3.30), followed by living (3.26), entertainment (3.13), and others (2.80). It shows that students were generally satisfied with the study, entertainment and living conditions. However, the other services got a low degree (2.80), which implies that some extra services can be improved to satisfy students' extra needs.

Similarly, in the importance dimension, the average importance of living (4.18) ranks the highest among the primary needs, followed by study (4.13), others (3.47), and then entertainment (3.3). It's not difficult to see that students are more concerned with living and study conditions of the residence. Additionally, all four categories of importance value are greater than 3.0, which also shows that all types of needs are important, although others and entertainment have a less degree.

### **4.4.3. Analysis of Comparison of Perception Value in Terms of Location and Degree**

As mentioned above, there are totally nine residences provided by NUS for student accommodation. Gillman Heights is the only off-campus residence and accommodates graduate students. Some graduate students also live in studio apartments in two blocks in Prince George's Park. From Figure 4.2, it is obvious that Gillman Heights has the lowest average satisfaction degree in both study (2.29) and entertainment (1.76) among all residences. And they were far from the satisfaction degree 3.0.



- |  |                    |                 |
|--|--------------------|-----------------|
| 1- Prince George's Park                        | 2- Gillman Heights | 3- Eusoff Hall  |
| 4- Kent Ridge Hall                             | 5- KEV II Hall     | 6- Raffles Hall |
| 7- Sheares Hall                                | 8- Temasek Hall    |                 |
| 9- Kuok Foundation House and Extension Block A |                    |                 |

Figure 4.2. Comparison of perception value in terms of location

#### **4.4.4. Analysis of Differences between Undergraduates and Graduates**

Figure 4.3 shows the difference of perception of each requirement between undergraduate students and graduate students. The values are from what the average satisfaction degree of undergraduate students minus that of graduate students. This figure shows that there are four significant differences between undergraduate and graduate. The three statements with most significant difference are “Internet facilities are easily available”, “Various sports facilities are nearby”, and “A lot of activities are organized for residents to encourage communication and to generate friendship”. As discussed before, the three significant differences are likely due to the effect of Gillman Heights.

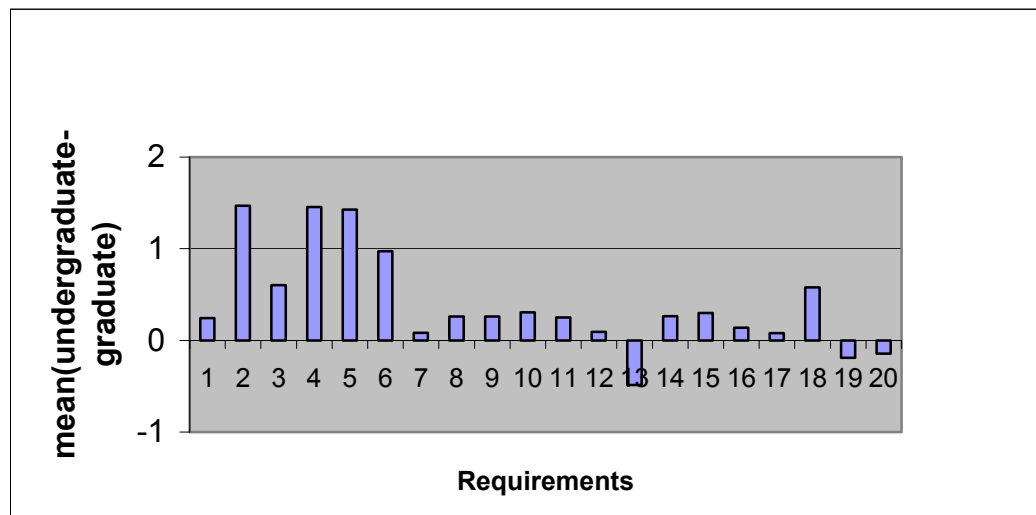


Figure 4.3. Difference of perception of each requirement between undergraduates and graduates



As a consequence, we conduct a further analysis to find out whether the huge differences between undergraduates and graduates are due to the effect of Gillman Heights.

From Figure 4.4, we can see that graduate students ranked Prince George's Park a much higher degree in study (3.58) than Gillman Heights (2.30). Prince George's Park was also ranked a degree of entertainment 2.90 and Gillman Heights was only ranked 1.72. It shows that graduate students feel more satisfied living on-campus than off-campus. Especially the degree of entertainment is rather low in Gillman Heights. And it also explains that the differences between undergraduate and graduate students are partly due to the effect of Gillman Heights.

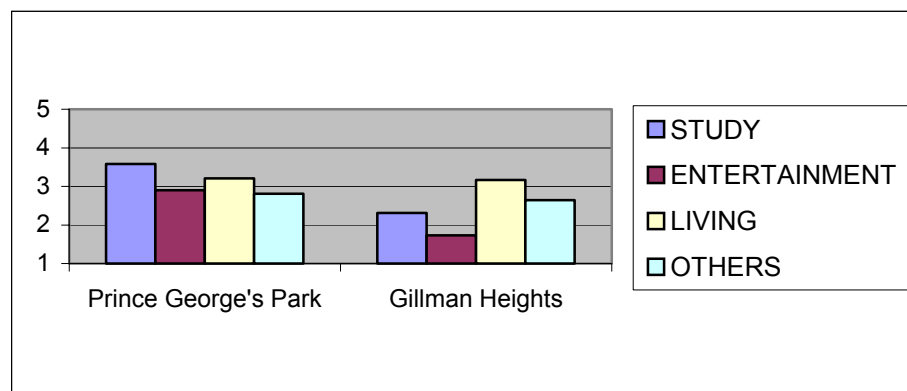


Figure 4.4. Comparisons between Prince George's Park and Gillman Heights in terms of satisfaction degree of graduate students

## **4.5. House of Quality (HOQ)**

### **4.5.1. Construction of the HOQ**

Seven steps were adopted to complete the HOQ for student accommodation services by NUS.

As a customer-driven method, the first step of applying QFD to the student accommodation services was to identify its customers. A commonly used approach to identify the right customers is to ask “Who must be satisfied with the service in order to be considered successful?” It is logical that the students who live in the residences provided by NUS are the primary customers of the accommodation services.

The second step was the identification of user requirements, namely “Whats”. After the email-based survey was found out to be ineffective, one-to-one interviews were employed to collect user requirements. One-to-one interviews can also help to effectively probe for details. 15 students who were current customers were interviewed to get their requirements, as we mentioned before. What is interesting is that it turned out that the first 5 students contributed most for gathering the requirements. The following students only had three more new needs. This conforms to what Griffin and Hauser (1993) argued that 20 to 30 interviews are necessary to identify 90% or more of customer needs. Several similar needs were combined to one. At the end, a total of 20 user needs of student accommodation services were confirmed.

The following step was used to capture the importance degree for each user need. A survey was conducted similar to the survey for the perception of performance. 30 students gave their ratings of the importance value to each statement.

The fourth step was the identification of the “Hows”. The “Hows” are how you are going to satisfy the specific customer “Whats”. They are measurable, and something that can be worked on to satisfy the identified wants and needs. For each “What”, one or several “Hows” were developed. For example, to satisfy the students’ need of “availability of Internet facilities”, we could ask the question that “How to satisfy availability of the Internet facilities? That is, what could be done in order to get

easier access to the Internet?”. Then two related issues can be identified, one is “computer room” and another is “networking points in rooms”. Similarly, all the 20 “Whats” were converted into 25 corresponding “How” (see Figure 4.5).

The “Whats” and “Hows” were linked via a relationship matrix which showed how much each “How” affect each “What”. In the relationships matrix, the strong, medium, and weak relationships were cross-referenced. As the top box indicates (see Figure 4.5), they carry points of 9.0, 3.0, and 1.0 respectively. Take the user need “availability of Internet facilities” as an example again. It may be determined that the improvement of “computer room” and “networking point in rooms” would have a strong impact on the fulfillment of this particular need. On the other hand, the improvement of “computer room” would also have moderate contribution to satisfy “provide a cozy environment for study”.

Next step was to identify the correlations among the “Hows”. The “roof” of the house is designed to cross-correlate the “Hows” against each other so that design conflicts and complimentary characteristics can be identified. Each cell in the roof matrix shows either a positive or a negative correlation for all pairs of “Hows”. For example, increasing “number of food outlets” would result in corresponding improvement of “food type”. On the contrary, “offer household cleanliness service” may result in worse security in residences, and have a negative effect on “secure card access system”.

The final step was to set priorities in order to allocate the limited resources of the university. “Importance of the Hows” was generated from multiplying importance of “Whats” by strong/medium/weak relationships, and then adding all the vertical figures. Percent Importance is a conversion of the importance of “Hows” into

percentages to get an easy understanding. Finally, an absolute rank was also given to present the priority number.

#### **4.5.2. Analysis of the HOQ**

After the above seven steps, a completed HOQ for student accommodation services by NUS was developed as shown in Figure 4.5. The completed HOQ provides useful information on how to improve student accommodation services by NUS. It clearly lists the requirements of students who are current customers of student accommodation services, their relative importance degree, and corresponding level of customer satisfaction (perception of performance). It also provides a list of “Hows” to help achieve a quality student accommodation services in NUS. An absolute ranking of the importance of “Hows” shows the priorities, which help the university to allocate their limited resources based on the priorities.

As Figure 4.5 shows, the three most important “Hows” are “various routes and prolonged time table of shuttle bus”, “open new route from off-campus residence to campus”, and “room type”. This implies that the university should considerate these three in advance. And what is exciting that, NUS has acted on improving shuttle bus services. NUS has added new routes, adjusted previous routes, and increased the frequencies. Similarly, the three least important “Hows” were identified as “update information on the website at short intervals”, “offer household cleanliness service in residences” and “process time for repair”. Thus they may be considered only after other “Hows” are well developed and satisfied.

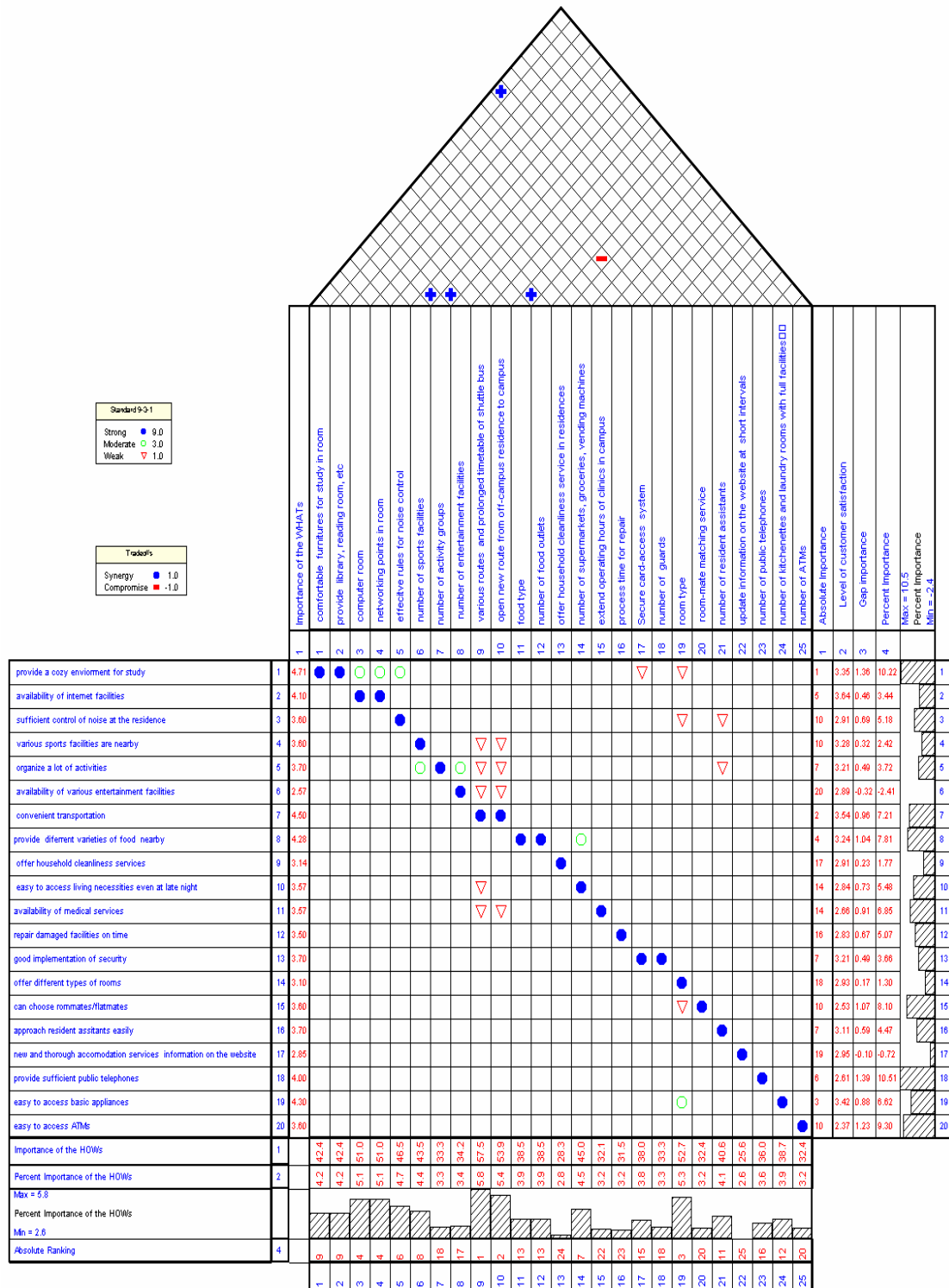


Figure 4.5. A completed HOQ for student accommodation services by NUS

## **4.6. Discussion**

This chapter presents a case study of identifying and meeting students' needs of accommodation services by the National University of Singapore. Although QFD has been applied in higher education for many years, most has been focused on research and teaching, for example, research plan development, degree program design, teaching improvement, and curriculum change, etc. No previous paper has been done only for the accommodation services, except some that just treated accommodation services as a small part of their studies. However, this study provides a thorough view on how to achieve quality excellence in accommodation services, which is agreed by many researchers as an important part of students' experiences in universities. Especially in today's fierce competition environment, it's good to know how to achieve student satisfaction from non-academic areas. In future research, we can also look at other non-academic parts, such as enrollment and extracurricular activities.

In this study, there are obvious customer segments due to nine different residences, including Prince George's Park, Gillman Heights, Eusoff Hall, Kent Ridge Hall, KEV II Hall, Raffles Hall, Sheares Hall, Temasek Hall, and Kuok Foundation House and Extension Block A. At the first sight, the results may show significant differences in graduates and undergraduates, and among the residences. But after further analyses, we can see that the differences exist mainly due to the different residences. Students actually had similar views for the accommodation services. They considered "study" and "living" the most important, which was rather reasonable.

From the analysis of the HOQ, the three most important "Hows" identified were "various routes and prolonged time table of shuttle bus", "open new route from off-campus residence to campus", and "room type". This implied that the university

should consider improving the shuttle bus service first, which surely would improve student satisfaction.

This study demonstrates that QFD can be applied in other activities in higher education, other than teaching and research. This chapter describes the detailed process of data collecting, data analysis, and the construction of the HOQ. It provides a framework for researchers to analyze service quality within similar context. The results of this study also show that QFD is very useful in ascertaining students' desires, prioritizing their requirements, and giving the corresponding improvement directions.

## **Chapter 5**

# **Using SERVQUAL to Measure Service Quality in Distance Learning**

Distance learning (or e-learning) is one of the most rapidly developing and growing areas in education, which is advantageous than the traditional education in many aspects. With the increasing popularity of distance learning programs, the needs to achieve quality excellence in these programs are increasing. However, not much research attention has been received in this area. In this chapter, service quality for Internet-based Learning provided by a Chinese major distance learning service provider (Huaxia Dadi Distance Learning Services Company) is analyzed and evaluated. A method of measuring perceived service quality based on triangular fuzzy numbers is applied in this chapter, which is designed to overcome linguistic problems.

## **5.1. Service Quality in Distance Learning**

### **5.1.1. History of Distance Learning**

The rapid technological advances in the late 20th century, especially the Internet, have resulted in a proliferation of distance learning programs available from an ever-growing number of institutions. Nicholson (1998) speculated that in the 21st century universities would evolve quite different from their precursor institutions. He



imagined that in 2030 there will be two types of higher education. One will be “Experience Camps”, funded by enterprises that provide study and social service experiences for a relatively small group of students. The other will be “Advanced Learning Networks”. These are vast distance learning enterprises without campuses, which provide high quality education to a great number of students around the world. In his opinion, distance learning is growing not only as a supplement to traditional institutions and programs, but also as a replacement for those institutions and programs.

A basic definition of distance learning is “any formal approach to learning in which a majority of the interaction occurs while educators and learners are at a distance from one another” (Verduin and Clark, 1991). Historically, distance learning can be traced back to the 1700s and the beginnings of print-based correspondence study in the U.S. (Willis, 1993). Now learners can be reached through many kinds of media like the Internet, videoconferencing, audio conferencing and computer programs. With the enormous growth of distance learning technologies, students have more options than ever for using various forms of media to accomplish their learning goals.

Taylor (1995) summarized that distance education operations have evolved through four generations:

First, the Correspondence Model based on print technology;

Second, the Multi-media Model based on print, audio and video technologies;

Third, the Telelearning Model based on applications of telecommunications technologies to provide opportunities for synchronous communication; and

Fourth, the Flexible Learning Model based on online delivery via the Internet.

A conceptual framework is shown in Table 5.1.

Table 5.1. Models of distance education - a conceptual framework (reproduced from Taylor, 1995)

<b>Models of Distance Education and Associated Delivery Technologies</b>	<b>Characteristics of Delivery Technologies</b>			
	<b>Flexibility</b>			<b>Advanced Interactive Delivery</b>
	<b>Time</b>	<b>Place</b>	<b>Pace</b>	
<b>First Generation - The Correspondence Model</b> Print	Yes	Yes	Yes	No
<b>Second Generation - The Multi-media Model</b> Print Audiotape Videotape Computer-based learning (eg. CML/CAL) Interactive video (disk and tape)	Yes	Yes	Yes	No
	Yes	Yes	Yes	No
	Yes	Yes	Yes	No
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
<b>Third Generation - The Telelearning Model</b> Audio teleconferencing Video conferencing Audiographic Comms. Broadcast TV/Radio + Audio teleconferencing	No	No	No	Yes
	No	No	No	Yes
	No	No	No	Yes
	No	No	No	Yes
<b>Fourth Generation - The Flexible Learning Model</b> Interactive multimedia (IMM) Internet-based access to WWW resources Computer mediated communication	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes

### **5.1.2. Customer Satisfaction in A Distance Learning Program**

As more and more institutions embrace Internet-based education, competition for students is becoming increasingly competitive on a global scale. The result is that education will become increasingly market driven, such that in the near future institutional success will depend primarily on students' perceptions of flexibility of access, quality of service and value for money. To respond to this situation, educational institutions must recognize and meet the needs of learners who are quite different from the traditional students of the past.

When Cooper et al. (1998) explored the needs and expectations of remote library users, they found that remote users (both students and faculty) had their own unique characteristics, needs and expectations. To promote user satisfaction, library staff needs to better understand users and their needs as well as help users to accomplish those needs.

The distinctions between distance learning and traditional resident instruction are obvious, for example, the modes of delivery and the distances that separate students and teachers in both time and space. DiBiase (2000) emphasized in his article that distance learners are a qualitatively different, older population with different educational needs from traditional on-campus undergraduates and graduate students.

To learn fully, effectively, and efficiently, Moore believed that what all distance learners want and deserve is (Gibson, 1998):

- Content that they feel is relevant to their needs;
- Clear directions for what they should do at every stage of the course;
- As much control of the pace of learning as possible;
- A means of drawing attention to individual concerns;

- A way of testing their progress and getting feedback from their instructions; and
- Materials those are useful, active and interesting.

The assessment based on learners is crucial to the success of a distance learning program. Chang (2002) proposed that three criteria should be met to be a well-considered virtual university supporting system: Administration Criterion, Awareness Criterion and Assessment Criterion. He believed that assessment is the most important and difficult part of distance education. And the tools to support the evaluation of student learning should be sophisticated enough to avoid biased assessment. Thorpe (1988) also pointed out that evaluation is important for the achievement of goals which matter to the practitioners of distance and open learning, such as the quality of learning experience they provide and the effectiveness of their programs or courses. She believed that evaluation should be incorporated as a regular set of practices in what they do.

### **5.1.3. Internet-based Learning**

The Internet and the Web help overcome the barriers of time and space in teaching and learning (Kerka, 1996). As an effective platform for delivering virtual courses, the Internet has significant advantages compared with other distance learning medias. Wulf (1996) listed some of the advantages as follows: universal appeal, global access, consistent interface, media richness, lower connection costs, quicker development time than videos or CD-ROMs, easier updating of content, and an interactive communications environment. Since computer communication provides the learner anonymity to some degree and may “level the playing field” by allowing

learners to be judged on their own merit, equity is another advantage of learning through the Internet (Kerka, 1996).

Of course, there are also many who feel that the quality of the teaching, the support that students receive and the information provided to students are not good in a distance education environment compared with a conventional face-to-face situation (Davies et al., 2001). For example, Filipczak (Kerka, 1996) believed distance learning on the Internet was not necessarily more effective, although it could be cheaper, faster, and usually more efficient than other learning modes.

Numerous studies have been conducted that compare course outcomes between distance learning and on-campus learning. Verduin and Clark (1991) reviewed 56 studies comparing academic achievement of students in conventional classrooms to students in a variety of distance learning programs and found that “students using distance education methods achieve similar, if not superior, results when compared with conventional methods of teaching”. Similarly, Arbaugh (2000) found that while there were no significant outcome differences in MBA students taking Web-based course, women participated more than men in discussions. Motiwalla and Tello (2000) explored levels of student satisfaction within a Web-based model that incorporated real-time (synchronous) and non-real-time (asynchronous) interaction between faculty and students in a paced, semester-based format. A report from the Institute for Higher Education Policy (1999) summarized the major shortcomings of research conducted regarding the effectiveness of distance learning courses. These include:

- An emphasis on student outcomes for individual courses rather than academic programs;

- A lack of research regarding the impact of individual learning styles on student learning;
- A lack of research on the impact of the use of multiple technologies;
- A limited theoretical or conceptual framework; and
- A lack of longitudinal studies and controlled groups.

In this study, some of the shortcomings described above are to be addressed. First, the study was conducted across the whole distance learning web, rather than on one or two web-based courses. Second, the study reviewed the impact of the use of multiple communications' technologies in the Web-based program on the dependent variables, student satisfaction and importance. Finally, the nature of the sample, the students who enrolled in Huaxia Dadi Distance Learning Web for study, provides future opportunities to conduct longitudinal studies.

#### **5.1.4. E-learning Services and System Provided by Huaxia Dadi Distance Learning Web**

Founded in December 1999, the Beijing Huaxia Dadi Distance Learning Services Co. Ltd is one of the major distance learning service providers in China. It is accredited as a high-tech company by the Beijing Science and Technology Committee and it is involved in key national education and science projects. The website ([www.edu-edu.com.cn](http://www.edu-edu.com.cn)) was launched on April 25, 2000, which is a well-known adult education and training website in China. Huaxia Dadi has developed over 300 courses in various categories, mainly in Training Programs, Self-study, Professional Qualification Programs and Language Training Programs.

The E-Learning System (ELS) adopted by Huaxia Dadi Distance Learning Web was internally designed and developed. The design of ELS, based on intelligent

agent technology, embodies the learners-centered teaching principle, creates a virtual online learning environment for adults users and guides and supports them in terms of learning methods, strategies and procedures. The framework of this ELS Platform is shown in Figure 5.1.

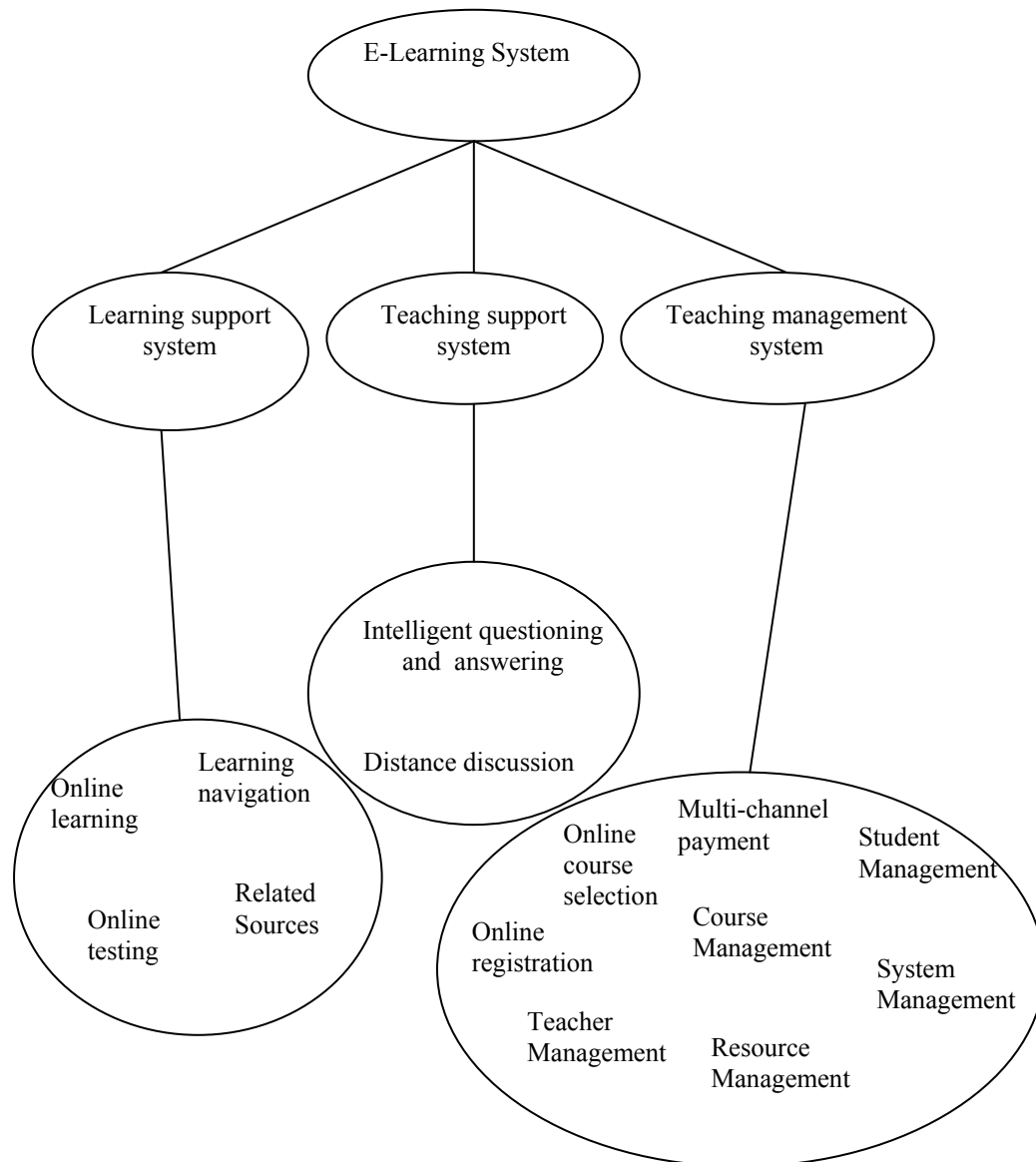


Figure 5.1. The framework of ELS Platform used by Huaxia Dadi Distance Learning Web

The structure of this ELS platform is based on the following three systems:

1. Learning support system: it supports students' learning, communication, inquiry, online testing, and download of related resources.
2. Teaching support system: it supports communication and discussions between students and teachers and manages instructional data and student information.
3. Teaching management system: it supports management of accounts, students, teachers, courses and related resources.

Based on these three systems, the functions and features of the ELS platform are listed as follows:

1. Online registration: it supports registration of individuals, groups and multi-identity users.
2. Online course selection: it supports cross section of various specialties and supports review of course selection and reselection of courses.
3. Multi-channel payment: it provides different payment channels, such as online payment, learner's card, money order and bank transfer.
4. Online learning: it provides individualized learning environment, organizes learning resources using hypertext and supports multimedia learning.
5. Learning navigation: it provides users with lessons' structure maps, learning results, suggestions and intelligent tips.
6. Intelligent question-and-answering: it answers questions automatically based on professional knowledge base or by an online knowledge expert.
7. Distance discussion: it supports synchronous and asynchronous online discussion.
8. Online testing: it provides self-chosen parameters for self-organized exam papers, simulated examinations, intensified training and auto-grading function.



9. Related resources: it provides various resources directly related to the current lesson; supports video and audio presentation.
10. Student management: it manages student's selecting, taking and finishing courses, as well as student's account, money and study record.
11. Teacher management: it manages the teaching procedure, teacher's account and teaching record.
12. Course management: it manages the publishing, changing and deleting of courses.
13. Resource management: it manages upload and download of instructional resources related to courses.
14. System management: it provides tools for system management.

## **5.2. Measuring Service Quality of Internet-based Learning**

### **5.2.1. Introduction**

One of the purposes of this section is to examine the different dimensions of service quality. This kind of information has practical implications for managers of distance learning service providers as they can direct their resources to improve weak service dimensions and to refine their marketing efforts so that customer expectations are met by the services delivered. The survey, adapted from the SERVQUAL instrument (Parasuraman et al., 1988, 1991), was designed to establish the number of dimensions of service quality in Internet-based Learning, which the students themselves consider to be the elements of service quality. In order to enhance student perceptions of service quality, the findings suggest valuable ways on how to allocate the available limited resources in the institutions, which provide distance learning

services. The following is the adopted two-stage research method, which gives a rationale for the specific adaptation of the SERVQUAL instrument.

### **5.2.2. Methodology**

#### **5.2.2.1 Questionnaire Design**

To apply a SERVQUAL-based survey in the Internet-based Learning context, two operational issues were addressed. First, it was recognized by the instigators themselves (Parasuraman et al., 1991) that the wording of the questions needs to be tailored to the specific service application, in a language with which the respondents can identify. Consequently, the first stage of the research was to consult students via focus groups to test and refine the wording and understanding of potential survey questions.

Second, the original SERVQUAL questionnaire was designed to measure both expectations (forecast) and perceptions (what actually happens) of a firm's service quality. Cronin and Taylor (1992) disputed the appropriateness of measuring the gap between expectations and perceptions. They developed and tested an alternative instrument, SERVPERF, which measured performance only based on the notion that "service quality should be measured as an attitude". From customers' standpoints, conveniently, we replace perceptions by satisfaction degree as well as expectations by importance degree. In short, perceived service quality is the discrepancy between satisfaction degree and importance degree.

Modification to suit the distance learning setting resulted in the changes to some existing items, the inclusion of new items and deletion of old items. For example, the dimension of tangibles is not suitable to a Web-based course delivery process, so it was replaced by the attitudes of a good website, such as "Website

should be visually appealing” and “Website should be easy to navigate”. An original assurance item, “Guests feel safe in their transactions with employees”, was replaced by “Firewall should be used to secure online monetary transaction”, which will be much clearer for respondents. In all, twelve items were either modified or added to the original SERVQUAL scale, and eleven items were deleted, leaving a total of 23 items in the final survey.

The items shown in Table 5.2 were measured on a five-point scale ranging from “very important” to “very unimportant” on the level of importance and “excellent” to “very poor” on the level of satisfaction. In addition, a separate overall service quality measure that used a single rating 5-point scale (from “excellent” to “very poor”) was included to get the satisfaction level of overall service quality. The questionnaire is shown in Appendix C.

#### 5.2.2.2. Sample Size and Data Collection

A total of 1500 questionnaires were distributed by email to the registered students of Huaxia Dadi Distance Learning Web ([www.edu-edu.com.cn](http://www.edu-edu.com.cn)) in China. The recruitment process for this study took place for a duration of one month, from March to April 2002. A sample size of 492 participants was collected, representing a response rate of 32.8%. Among all the returned questionnaires, only 350 were considered as valid.

The participants of this study are all registered students of Huaxia Dadi Distance Learning Web, who can be considered as experienced customers in Internet-based Learning. 66% of the respondents were male, and most of the respondents were between 21 and 30 years of age. 57% of the respondents in this study had Internet experiences for one to three years. And among the respondents, 42% were

poly/diploma students. Degree holders also occupied nearly 25% of all respondents. Besides, 64% were students who intend to take courses of Self Study Exams.

Table 5.2. SERVQUAL statements

1. Course materials and instructions should be accurate.
2. Course materials and lectures should be accessed conveniently online.
3. There should be hotlinks to get the software for viewing online materials and lectures easily.
4. Chat rooms, forums and email lists should be available for instructors and students to interact.
5. Online quiz and exam with real-time grading should be available.
6. Reference links (links to related journals, articles, videos, etc.) should be available.
7. Instructors and other staff should be easy to contact.
8. Instructors and other staff should always be willing to help you.
9. Individual attention should be given to students based on records and performance.
10. Emails should remind students for related information (such as update course materials, lectures and coming activities, etc.)
11. Websites should be accessible all the time.
12. Website should be easy to navigate.
13. Website should be visually appealing.
14. The contents and information of website should be clearly labeled and organized.
15. The contents and information of course website should be updated timely.
16. There should be clear instructions for students to use the website.
17. Email and hotline are provided for help.
18. E-mail and call responses should be relevant and accurate.
19. Services should be provided on time as planned.
20. Students' feedback should be processed promptly.
21. Emails or questionnaires should be used to conduct student satisfaction surveys.
22. There should be various modes of payment for paying services.
23. Firewall should be used to secure online monetary transaction.

### **5.2.3. Data Analysis and Results**

#### **5.2.3.1. Dimensions of Service Quality in Web-based Course Service**

To explore the dimensions of quality in an E-learning setting, a factor analysis was performed and the results were subjected to varimax rotation. Factors with Eigenvalues greater than one were extracted. The general pattern of loadings is shown in Table 5.3, which suggests that, in this study, five factors emerge as the dimensions of service quality in E-learning setting, which is not similar to the original SERVQUAL model.

Seven of the twenty-three variables have not been included in Table 5.3 as they had factor loadings of less than 0.5 on all five factors. We have labelled the five factors as: “responsiveness elements”, “website elements”, “study elements”, “payment elements”, and “course materials elements”.

1. Responsiveness elements: These items are related to timely responsiveness of employees to students’ needs (6 items);
2. Website elements: These items are related to the essential attributes of a workable website (3 items);
3. Study elements: These items are essential to enable students to fulfill their study obligations (4 items);
4. Payment elements: These items are related to payment service (2 items); and
5. Course material elements: These items are related to the essential attributes of course materials provided by website - accuracy, accessibility, etc (2 items).

It should be noted that the factors recovered here do not correspond with those recovered in the early SERVQUAL studies, where there were five factors labeled responsiveness, reliability, empathy, assurance, and tangibles. Parasuraman et al.

(1991) believed that these five factors represent the generic dimensions of service quality. However, many subsequent studies of service quality in a variety of services have also failed to recover the five dimensions of service quality (Buttle, 1996).

Consequently, our discussion in the next section will focus on the five factors emerging from our data rather than the original SERVQUAL dimensions of service quality. A summary of the essential content of the dimensions of service quality in Internet-based Learning is shown in Table 5.4.

#### 5.2.3.2. Using Fuzzy Numbers in SERVQUAL to Evaluate Service Quality of Internet-based Learning

Fuzzy set theory was developed for solving problems whose descriptions of activities and observations are imprecise, vague and uncertain. Lingual expressions (for example, satisfied, fair, and dissatisfied) are regarded as the natural representation of the preference or judgment. These characteristics indicate the applicability of fuzzy set theory in capturing the decision makers' preference structure. Therefore, to strengthen the comprehensiveness and reasonableness of the decision-making process, it will be better to employ fuzzy set theory in the process to apply SERVQUAL.

In marketing research, most questionnaires use Likert scales to measure respondents' attitude. However, our method based on triangular fuzzy numbers makes linguistic terms more objective, and is different from general research using statistical methods in marketing research.

We investigated the valid answers of 350 registered students of Huaxia Dadi Distance Learning Web. Following the seven steps below, we created Table 5.5 and Table 5.6 by employing the fuzzy arithmetic and the process model proposed in Chapter 3.

Table 5.3. Rotated Component Matrix

	Component				
	1	2	3	4	5
V1D	-1.982E-02	.242	8.710E-02	-1.606E-02	<b>.790</b>
V2D	.225	9.303E-02	.228	.239	<b>.588</b>
V3D	.457	-9.420E-02	4.380E-02	.143	.476
V4D	5.808E-02	-1.964E-02	<b>.762</b>	.155	9.739E-02
V5D	.284	.133	<b>.625</b>	.252	.110
V6D	.230	.287	<b>.517</b>	5.611E-02	.326
V7D	.475	.318	<b>.566</b>	3.939E-02	3.776E-02
V8D	<b>.654</b>	.251	.304	-6.393E-02	-2.772E-02
V9D	.459	.164	.449	8.744E-02	9.027E-03
V10D	.119	<b>.538</b>	.378	2.640E-02	.226
V11D	.225	<b>.575</b>	2.508E-02	.141	.179
V12D	.221	<b>.708</b>	.107	9.771E-02	-4.617E-03
V13D	.444	.273	4.730E-02	.346	2.019E-02
V14D	.339	.434	9.113E-02	.234	.237
V15D	<b>.586</b>	.376	4.337E-02	-1.266E-02	.277
V16D	.170	.476	.171	.422	5.430E-02
V17D	<b>.513</b>	.202	.304	.151	.250
V18D	<b>.541</b>	.227	.212	.209	.211
V19D	<b>.560</b>	.373	.249	.214	1.044E-02
V20D	<b>.718</b>	5.834E-02	.143	.202	.162
V21D	.416	.285	.150	.425	-1.445E-02
V22D	-1.941E-02	.392	.194	<b>.690</b>	2.645E-02
V23D	.226	-5.482E-02	.131	<b>.741</b>	.240

Extraction Method: Principal Component Analysis.  
Rotation Method: Varimax with Kaiser Normalization.  
A Rotation converged in 11 iterations.

Table 5.4. Dimensions of service quality for Internet-based Learning

Factor	Main emphasis
Responsiveness (Factor 1)	Instructors and other staff should always be willing to help you. The contents and information of course website should be updated timely. Email and hotline are provided for help. E-mail and call responses should be relevant and accurate. Services should be provided on time as planned. Students' feedback should be processed promptly.
Website (Factor 2)	Websites should be accessible all the time. Website should be easy to navigate. Website should be visually appealing.
Study (Factor 3)	Chat rooms, forums and email lists should be available for instructors and students to interact. Online quiz and exam with real-time grading should be available. Reference links (links to related journals, articles, videos, etc.) should be available. Instructors and other staff should be easy to contact.
Payment (Factor 4)	There should be various modes of payment for paying services. Firewall should be used to secure online monetary transaction.
Course Materials (Factor 5)	Course materials and instructions should be accurate. Course materials and lectures should be accessed conveniently online.



Step 1: According to each respondent's importance degree and satisfaction degree, in linguistic terms, their triangular fuzzy numbers are created by Eq. (3.1).

Step 2: Applying Eq. (3.4) and Eq. (3.5), average triangular fuzzy numbers are created to aggregate respondents' importance degree and satisfaction degree, as what are shown in Table 5.5.

Step 3: Employing Eqs. (3.6) - (3.8), the weak and or strong attributes are clarified (see Table 5.5).

Step 4: Defuzzifying average fuzzy number to BNP (Best Nonfuzzy Performance) value by the Center-of-Area method using Eq. (3.9) (see Table 5.5).

Step 5: Applying Eqs. (3.4) and (3.5) again, average triangular fuzzy numbers for each dimension (which are found in section 5.2.3.1) are created to aggregate respondents' importance degree and satisfaction degree, as what are shown in Table 5.6.

Step 6: Employing Eqs. (3.6) - (3.8) to clarify weak or strong dimensions (see Table 5.6).

Step 7: Defuzzifying average fuzzy number for each dimension to BNP (Best Nonfuzzy Performance) value by the Center of Area method using Eq. (3.9) (See Table 5.6).

Table 5.5 Service quality evaluations by triangular fuzzy number for each attribute

	Average triangular fuzzy number of importance degree	Average triangular fuzzy number of satisfaction degree	BNP value for importance degree	BNP value for satisfaction degree	$v=v_b-v_a$
V1	(4.97,6.94,7.62)	(3.07,5.04,6.89)	6.51	5.00	-1.61
V2	(4.75,6.74,7.63)	(3.21,5.15,6.86)	6.37	5.07	-1.37
V3	(3.93,5.87,7.11)	(2.78,4.76,6.61)	5.64	4.72	-0.97
V4	(4.22,6.15,7.26)	(3.49,5.46,7.06)	5.31	4.69	-0.66
V5	(4.00,5.97,7.20)	(2.61,4.57,6.38)	5.88	5.34	-0.58
V6	(4.03,5.97,7.18)	(2.75,4.70,6.57)	5.72	4.52	-1.25
V7	(3.59,5.49,6.86)	(2.81,4.73,6.53)	5.73	4.67	-1.11
V8	(4.16,6.10,7.29)	(3.07,5.04,6.89)	5.85	4.91	-1.00
V9	(3.82,5.75,7.08)	(3.01,4.94,6.78)	5.55	4.57	-1.03
V10	(4.18,6.14,7.34)	(2.63,4.57,6.50)	5.89	4.66	-1.29
V11	(4.33,6.27,7.30)	(2.73,4.68,6.58)	5.97	5.51	-0.50
V12	(4.35,6.31,7.42)	(3.69,5.66,7.18)	6.03	5.35	-0.73
V13	(3.17,5.05,6.57)	(3.49,5.45,7.10)	4.93	4.73	-0.22
V14	(4.06,6.00,7.29)	(2.82,4.77,6.61)	5.78	4.89	-0.94
V15	(4.38,6.33,7.40)	(2.98,4.93,6.75)	6.04	4.52	-1.59
V16	(3.76,5.68,7.05)	(2.60,4.54,6.42)	5.50	5.22	-0.31
V17	(3.85,5.77,7.09)	(3.31,5.29,7.04)	5.57	5.03	-0.58
V18	(4.27,6.21,7.37)	(3.14,5.09,6.85)	5.95	4.87	-1.14
V19	(4.17,6.10,7.31)	(2.94,4.89,6.78)	5.86	4.83	-1.08
V20	(4.49,6.43,7.46)	(2.90,4.87,6.72)	6.13	4.85	-1.34
V21	(3.62,5.54,6.98)	(2.94,4.90,6.71)	5.38	5.33	-0.07
V22	(3.77,5.67,7.05)	(3.44,5.39,7.15)	5.50	5.45	-0.05
V23	(4.68,6.62,7.46)	(3.60,5.59,7.17)	6.25	5.30	-1.02

Table 5.6. Service quality evaluations by triangular fuzzy number for each dimension

Dimension	Main evaluation criteria	Average triangular fuzzy number of importance degree	Average triangular fuzzy number of satisfaction degree	BNP value for importance degree	BNP value for satisfaction degree	$v=v_b-v_a$
Responsiveness	V8	(4.22,6.17,7.01)	(3.06,5.01,6.83)	5.8	4.97	-0.93
	V15					
	V17					
	V18					
	V19					
	V20					
Website	V10	(4.27,6.24,7.35)	(3.02,4.97,6.75)	5.95	4.91	-1.04
	V11					
	V12					
Study	V4	(3.96,5.82,7.13)	(2.92,4.87,6.64)	5.64	4.81	-0.83
	V5					
	V6					
	V7					
Payment	V22	(4.23,6.15,7.25)	(3.52,5.49,7.16)	5.7	5.39	-0.31
	V23					
Course Materials	V1	(4.86,6.84,7.63)	(3.14,5.09,6.87)	6.44	5.03	-1.41
	V2					

The v-value is to evaluate the perceived service quality, that is, the discrepancy between satisfaction degree and importance degree. As showed in Table 5.6, the v-value of each dimension is less than zero, which indicates they are all under an inferior condition, and it also means that a lot of work needs to be done to achieve student satisfaction. Among all the five dimensions, the “Payment” dimension has the least v-value (-0.31) and “Course Material” has the largest v-value of -1.41, which means, to Huaxia Dadi Distance Learning Web, “Course Material” is the weakest

dimension. If we can pay more attention to this dimension and make improvement on it, the degree of student satisfaction will be increased significantly. From Table 5.6, we also can find that the most important dimension is “Course Materials” (which has the largest BNP value of 6.44), and the least important dimension is “Study” (5.64). Moreover, the most satisfying dimension is “Payment” (5.39) and “Study” (4.81) is the worst.

For a more detailed analysis, we should look to Table 5.5. For each item’s v-value, the largest three v-values are V1, V15 and V2, that is “Course materials and instructions should be accurate” (-1.61), “The contents and information of course website should be updated timely” (-1.59) and “Course materials and lectures should be accessed conveniently online” (-1.37). This indicates they are under the most inferior condition. We notice that V1 and V2 are both from the “Course Materials” dimension.

In terms of BNP value for importance degree for each item, Table 5.5 shows that the largest three values are V1, V2 and V23, that is “Course materials and instructions should be accurate” (6.51), “Course materials and lectures should be accessed conveniently online” (6.37), and “Firewall should be used to secure online monetary transaction” (6.21). The two most important items are all from the “course materials” dimension. The same result also is concluded from above paragraph, the largest BNP value of importance degree for dimensions is “Course Materials” (6.44).

The least three values for importance degree is V13, V4 and V21, “Website should be visually appealing” (4.93), “Chat rooms, forums and email lists should be available for instructors and students to interact” (5.31) and “Emails or questionnaires should be used to conduct student satisfaction surveys” (5.38).

In terms of BNP value for satisfaction degree for each item, Table 5.5 shows that the largest three values are V11, V22 and V12, that is “Websites should be accessible all the time” (5.51), “There should be various modes of payment for paying services” (5.45) and “Website should be easy to navigate” (5.35). The least three values are V6, V9 and V15, that is “Reference links (links to related journals, articles, videos, etc.) should be available” (4.52), “Individual attention should be given to students based on records and performance” (4.57) and “The contents and information of course website should be updated timely” (4.52).

#### **5.2.4. Discussion**

Nowadays, education has become more and more market-driven. In the near future, success may primarily depend on the students’ perceptions of service quality provided by educational institutions. As a result, educational institutions must recognize and meet the needs of the students.

A number of conceptual and empirical studies about service quality in educational setting have been done, but little in the distance learning context. In this chapter, service quality for the Internet-based Learning, the latest version of distance learning, was analyzed and evaluated through a Chinese major distance learning service provider - Huaxia Dadi Distance Learning Web.

This study was conducted across the whole distance learning web, rather than only one or two Web-based courses as some of the researchers did before. And the results have shown a lot of valuable information for the Internet-based Learning in China.

A two-stage research method was adopted in this chapter and provided a rationale for the specific adaptation of the SERVQUAL instrument.

First, a principal components factor analysis, performed on data collected from a sample of 350 students, suggests that students' perceived service quality has five dimensions: "Responsiveness elements", "Website elements", "Study elements", "Payment elements", and "Course materials elements". The dimensions of service quality have practical meanings for the managers of the distance learning service providers because they can direct their resources to improve weak service dimensions and refine their marketing efforts so that customer expectations are met by the service delivered. From the study of this chapter, we have figured out that items related to "Course materials elements" dimension are most critical to the student satisfaction. Improving the items in this dimension will effectively and efficiently enhance the service quality of the Web-based courses provided by Huaxia Dadi.

We also note that the factors recovered here do not correspond with those recovered in the early SERVQUAL studies, where the five factors labeled as responsiveness, reliability, empathy, assurance, and tangibles. Although Parasuraman et al. (1991) represented that the five factors are the generic dimensions of service quality, many researchers have failed to confirm the five generic dimensions of service quality in a variety of services (Buttle, 1996).

Next, a method of measuring perceived service quality based on triangular fuzzy numbers was proposed in this chapter. This method overcome linguistic problems, such that the case study provided more objective information for Internet-based Learning in China. Seven steps were adopted when implementing SERVQUAL with linguistic data. Fuzzy set theory was adopted in this study, which is often used to solve imprecision, vagueness and uncertainty in problems. To make the decision-making process more comprehensive and reasonable, it will be much better to employ fuzzy set theory in the process of applying SERVQUAL. In addition, we should

notice that some factors would affect the results, such as the type of fuzzy numbers, defuzzification strategies, and the degree of fuzziness of fuzzy numbers.

The results from this study are very helpful for us to discover the facts of this distance learning web's service quality. For instance, as showed in Table 5.6, the v-value of each dimension is less than zero, which indicates all the dimensions are under an inferior condition. That is, a lot of work needs to be done to achieve student satisfaction in this distance learning web.

In order to enhance the student perceptions of service quality, the findings suggest valuable ways on how to allocate the available limited resources in the institutions, which provide distance learning services. From the results, we know that which dimension/item should be worked on immediately to efficiently improve the overall student satisfaction. For example, the "Course Materials" dimension has the largest BNP value, so the Huaxia Dadi Distance Learning Web should worked on the items in this dimension to most efficiently improve its overall service quality.

## **Chapter 6**

### **Conclusion**

This chapter is divided into two major sections. The first section, concluding remarks, includes the brief statements of the problems, the procedures employed in the research and the highlights of the major findings. The other section discusses the limitations of this study and what further research needs to be done.

#### **6.1. Concluding Remarks**

With service industries playing a more and more important role in the overall economy of the world, service quality has become the single most researched area today. This thesis focuses on issues about analyzing, measuring and improving service quality in specific educational settings: accommodation services and distance learning.

The evaluation of service quality is influenced by many uncertain factors. First of all, to deal with the ambiguity of inputs in the evaluation of service quality by SERVQUAL, a practicable process model based on triangular fuzzy numbers is proposed in Chapter 3, which includes four steps: “Creating a triangular fuzzy number for the  $i$ th customer’s linguistic terms”, “Creating an average triangular fuzzy number from  $n$  triangular fuzzy numbers”, “Clarifying the weak or strong attributes” and “Defuzzification”. This proposed fuzzy approach presents a framework for easily evaluating service quality by SERVQUAL.



QFD, a popular approach used in the industry, has been applied in higher education to achieve a quality education. This study demonstrates that QFD is a useful tool which can be applied in other activities in higher education, other than teaching and research. We presented a case study of identifying and meeting students' needs of accommodation services, which have a great influence on students' experiences in universities. The detailed process of data collecting, data analysis and construction of the HOQ for this case study is described in Chapter 4. Based on the identified 20 user requirements from one-to-one interviews, we conducted a survey in the nine residences in NUS. After some descriptive statistical data analysis, we followed seven steps to complete the HOQ for student accommodations services. From the HOQ, three most important "Hows" come out, that is, "various routes and prolonged time table of shuttle bus", "open new route from off-campus residence to campus", and "room type", which could most effectively improve the service quality of the student accommodations services by NUS. From the processes and results, QFD is proved to be very useful in ascertaining students' desires, prioritizing their requirements and giving the corresponding improvement directions.

Distance learning has become one of the most rapidly developing and growing areas in education because of its advantages over the traditional education courses. Through a multitude of delivery mechanisms, especially the Internet, an overwhelming number of distance learning programs are available now. Educational institutions must recognize and meet the unique needs of distance learners, which are quite different from those of the traditional students. In Chapter 5, service quality for Internet-based Learning provided by a Chinese major distance learning service provider (Huaxia Dadi Distance Learning Services Company) is analyzed and evaluated through a survey by emails. A two-stage research method is adopted, which

provides a framework for the specific adaptation of the SERVQUAL instrument. Based on a modified 23-item SERVQUAL model, we conducted a survey to find the specific dimensions of service quality of Internet-based Learning according to the students' perception. A principal components factor analysis performed on data collected from a sample of 350 students suggests that students' perceived service quality has five dimensions: "Responsiveness elements", "Website elements", "Study elements", "Payment elements", and "Course materials elements". Moreover, a seven-step method for measuring perceived service quality based on triangular fuzzy numbers and SERVQUAL is used in this study, which is initially based on the four-step process model proposed in Chapter 3. This method overcomes linguistic problems, and helps to provide more objective information for Internet-based Learning in China. The findings suggests that the "Course Materials" dimension is under the most inferior condition, which should be concentrated on in order to efficiently improve the performance of the services provided by Huaxia Dadi.

Briefly, the contribution of this thesis is concluded as follows. In theoretical, this thesis proposed a process model based on triangular fuzzy numbers for SERVQUAL application. In practical, two case studies were carried out in relatively unexplored areas: accommodation services and distance learning, where useful information is provided for researchers and service providers.

## **6.2. Limitations and Suggestions For Future Research**

Due to the limitations involved in the current study, much more research could be carried out for further improvement.

Several points are summarized for future study, which are listed as follows:

First, the implementation of QFD in the accommodation services only dealt with the first phase of whole QFD process due to the limited cooperation with the Offices of Student Affairs in NUS. Future research could cooperate with the related offices in NUS to get the final HOQ and implement the HOQs in practice to check the effectiveness of QFD.

Second, to the application of SERVQUAL in a Chinese distance learning web, future research could consider whether the factor structure (dimensions) proposed in Chapter 5 is valid in other distance learning webs provided by other service providers, for this study was conducted solely in one Chinese service provider's registered students. And in the future, we can also conduct longitudinal studies to track this study, because the nature of the sample, the students who enrolled in Huaxia Dadi Distance Learning Web, provides future opportunities to do so.

Third, to the fuzzy set theory employed in the SERVQUAL model, in future research, we could use valid measuring methods based on other fuzzy numbers (like trapezoidal fuzzy numbers), and compare with other proposed methods, such as Hamming distance (Oliver, 1981) and Dubois's method.

Finally, QFD and SERVQUAL can use separately to serve the goal of achieving service quality excellence. Future research also may integrate the two techniques together and find whether they can make better analysis and give greater contribution.

## References

- Akao, Y. (1990), *Quality Function Deployment: Integrating Customer Requirements into Product Design*, Cambridge, MA: Productivity Press.
- Arbaugh, J.B. (2000), "Virtual classroom vs. physical classroom: An exploratory study of class discussion patterns and student learning in an asynchronous Internet-based MBA course", *Journal of Management Education*, 24 (2), pp. 213-233.
- Armacost, R.L., Coponaton, P.J., Mullens, M.A. and Swart, W.W. (1994), "AHP framework for prioritizing customer requirements in QFD: An industrialized housing application", *IIE Transactions*, 26 (4), pp. 72-79.
- Aswad, A. (1989), "Quality Function Deployment: A tool or a philosophy", SAE paper no. 890163, *Proceedings of SAE International Congress and Exposition*, Feb. 27-Mar. 3, Detroit (Society of Automotive Engineers).
- Babakus, E. and Boller, G.W. (1992), "An empirical assessment of the SERVQUAL scale", *Journal of Business Research*, 24 (3), pp. 253-268.
- Bahrami, A. (1994), "Routine design with information content and fuzzy quality function deployment", *Journal of Intelligent Manufacturing*, 5, pp. 203-210.
- Balthazard, P.A. and Gargeya, V.B. (1995), "Reinforcing QFD with group support systems: Computer-supported collaboration for quality in design", *International Journal of Quality and Reliability Management*, 12 (6), pp. 43-62.
- Bateson, J.E.G. (1977), "Do we need service marketing?", *Marketing Consumer Services: New Insights*, Cambridge, MA: Marketing Science Institute.
- Belhe, U. and Kusiak, A. (1996), "The house of quality in a design process", *International Journal of Production Research*, 34, pp. 2119-2131.
- Bellman, R.E. and Zadeh, L.A. (1970), "Decision making in a fuzzy environment", *Management Science*, 17 (4), pp. 141-164.
- Bird, S. (1992), "Objected-oriented expert system architectures for manufacturing quality management", *Journal of Manufacturing Systems*, 11 (1), pp. 50-60.
- Bitner, M.J. (1990), "Evaluating service encounters: The effects of physical surroundings and employee responses", *Journal of Marketing*, 54 (2), pp. 69-82.
- Bitner, M.J., Booms, B.M. and Tetreault, M.I. (1990), "The service encounter: Diagnosing favourable and unfavourable incidents", *Journal of Marketing*, 54 (1), pp. 71-84.

- Boulding, W., Kalra, A., Staelin, R. and Zeithaml, V.A. (1993), "A dynamic process model of service quality: From expectations to behavioral intentions", *Journal of Marketing Research*, 30 (1), pp. 7-27.
- Brensinger, R.P. and Lambert, D.M. (1990), "Can the SERVQUAL scale be generalized to business-to-business services? In knowledge development in marketing", *AMA's Summer Educators Conference Proceedings*, Boston, MA, pp. 289.
- Brown, T.J., Churchill Jr., G.A. and Peter, J.P. (1993), "Research note: Improving the measurement of service quality", *Journal of Retailing*, 69 (1), pp. 127-139.
- Bum, R. (1994), "Quality Function Deployment", ed. by Dale, B., *Managing Quality*, Prentice Hall.
- Buttle, F. (1996), "SERVQUAL: review, critique, research agenda", *European Journal of Marketing*, 30 (1), pp. 8-32.
- Carey, W.R. (1992), "Tools for today's engineer-strategy for achieving engineering excellence", Section 1: Quality Function Deployment, SAE paper no. 920040, *Proc. of SAE Int'l Congress and Exposition*, Detroit (Society of Automotive Engineers), Feb., pp. 24-28.
- Carman, J.M. (1990), "Consumer perceptions of service quality: An assessment of the SERVQUAL dimensions", *Journal of Retailing*, 66 (1), pp. 33-55.
- Chan, L.K. and Wu, M.L. (1998), "Prioritizing the technical measures in quality function deployment", *Quality Engineering*, 10, pp. 467-479.
- Chan, L.K. and Wu, M.L. (2002), "Quality function deployment: A literature review", *European Journal of Operational Research*, 143 (3), pp. 463-497.
- Chang, F.C.I. (2002), "Intelligent assessment of distance learning", *Information Sciences*, 140 (1-2), pp. 105-125.
- Chang, Y. H. and Yeh, C. H. (2002), "A survey analysis of service quality for domestic airlines", *European Journal of Operational Research*, 139 (1), pp. 166-177.
- Chen, C.L. and Bullington, S.F. (1993), "Development of a strategic research plan for an academic department through the use of quality function deployment", *Computers and Industrial Engineering*, 25 (1-4), pp. 49-52.
- Chen, S.M. (1996), "Evaluating weapon systems using fuzzy arithmetic operations", *Fuzzy Sets and Systems*, 77 (3), pp. 265 -276.
- Chen, T.C. (2001), "Applying linguistic decision-making method to deal with service quality evaluation problems", *International Journal of Uncertainty, Fuzziness and Knowledge-based Systems*, 9, (Suppl.2001), pp. 103-104.

- Chien, C.J. and Tsai, H.H. (2000), "Using fuzzy numbers to evaluate perceived service quality", *Fuzzy sets and systems*, 116 (2), pp. 289-300.
- Clausing, D. (1994), *Total Quality Development: A Step-by-step Guide to World-Class Concurrent Engineering*, New York: ASME Press.
- Clayton, M. (1993), "Towards total quality management in higher education at Aston-University---- A case study", *Higher Education*, 25 (3), pp. 363-371.
- Cohen, L. (1995), *Quality Function Deployment: How to Make QFD Work for You*, MA: Addison-Wesley.
- Cooper, R., Dempsey, P.R., Menon, V. and Millson-Martula, C. (1998), "Remote library users - needs and expectations", *Library Trends*, 47 (1), pp. 42-64 .
- Cronbach, L.J. (1951), "Coefficient alpha and the internal structure of tests", *Psychometrika*, 16 (3), pp. 297-334.
- Cronin, J.J. and Taylor, S.A. (1992), "Measuring service quality: A re-examination and extension", *Journal of Marketing*, 56 (3), pp. 55-68.
- Cronin, J.J. and Taylor, S.A. (1994), "SERVPERF versus SERVQUAL: Reconciling performance based and perception-minus-expectations measurement of service quality", *Journal of Marketing*, 58 (1), pp. 125-131.
- Crosby, P.B. (1979), *Quality Is Free: The Art of Making Quality Certain*, New York: New American Library.
- Crossfield, R.T. and Dale, B.G. (1991), "The use of expert systems in total quality management: An exploratory study", *Quality and Reliability Engineering International*, 7, pp. 19-26.
- Davies, G., Cover, C.F., Lawrence-Fowler, W. and Guzdial, M. (2001), "Quality in distance education", *Proceedings - Frontiers in Education*, 2, pp. T4F/1.
- Dean, E.B. (1992), "Quality Function Deployment for large systems", *Proceedings of the 1992 International Engineering Management Conference*, Eatontown, NJ.
- Delone, W.H. and Mclean, E.R. (1992), "Information systems success: The quest for the dependent variable", *Information Systems Research*, 3 (1), pp. 60-95.
- DiBiase, D. (2000), "Is distance education a faustian bargain?", *Journal of Geography in Higher Education*, 24 (1), pp. 130-135.
- Doukas, L. Parkins, W. and Jeyaratnam, C. (1995), "Integrating quality factors into system design", *IEEE International Engineering Management Conference*, Piscataway, NJ, pp. 235-240.

- Dube, L., Johnson, M.D. and Renaghan, L.M. (1999), "Adapting the QFD approach to extended service transactions", *Production and Operations Management*, 8 (3), pp. 301-317.
- Dubois, D. and Prade, H. (1988), *Possibility Theory: An Approach to Computerized Processing of Uncertainty*, New York: Plenum Press.
- Ermer, D.S. (1995), "Using QFD becomes an educational experience for students and faculty", *Quality Progress*, 28 (5), pp. 131-136.
- Finn, D. and Lamb, C. (1991), "An evaluation of the SERVQUAL scales in a retailing setting", *Advances in Consumer Research*, 18, pp. 483-490.
- Fisk, R.F., Brown, S.W. and Bitner, M.J. (1993), "Teaching the evolution of services marketing literature", *Journal of Retailing*, 69 (1), pp. 61-103.
- Fitzsimmons, J.A. and Fitzsimmons, M.J. (2001), *Service management: operations, strategy, and information technology*, New York: McGraw-Hill.
- Franceschini, F. and Rossetto, S. (1995), "QFD: The problem of comparing technical/engineering design requirements", *Research in Engineering Design*, 7 (4), pp. 270-278.
- Franceschini, F. and Rossetto, S. (1997), "Design for quality: Selecting a product's technical features", *Quality Engineering*, 9 (4), pp. 681-688.
- Franceschini, F. and Rossetto, S. (1998), "Quality function deployment: How to improve its use", *Total Quality Management*, 9 (6), pp. 491-500.
- Franceschini, F. and Rupil, A. (1999), "Rating scales and prioritization in QFD", *International Journal of Quality and Reliability Management*, 15 (7), pp. 753-768.
- Franceschini, F. and Zappulli, M. (1998), "Product's technical quality profile design based on competition analysis and customer requirements: An application to a real case", *International Journal of Quality and Reliability Management*, 15 (4), pp. 431-442.
- Fresen, J. (2002), "Quality in web-supported learning", *Educational Technology*, 42 (1), pp. 28-32.
- Fuller, N. (1998), "The house of quality", *Supply Management*, 3 (3), pp. 44-45.
- Fung, R.Y.K., Popplewell, K. and Xie, J. (1998), "An intelligent hybrid system for customer requirements analysis and product attribute targets determination", *International Journal of Production Research*, 36 (1), pp. 13-34.
- Garvin, D. A. (1983), "Quality on the line", *Harvard Business Review*, 61 (5), pp. 65-75.

- Ghiya, K.K., Bahill, A.T. and Chapman, W.L. (1999), "QFD: Validating robustness", *Quality Engineering*, 11 (4), pp. 593-611.
- Gibson, C.C. (1998), *Distance Learners in Higher Education: Institutional Responses for Quality Outcomes*, Wisconsin: Atwood Publishing Madison.
- Griffin, A. and Hauser, J.R. (1993), "The voice of the customer", *Marketing Science*, 12 (1), pp. 1-27.
- Gronroos, C. (1990), *Service Management and Marketing: Managing the Moments of Truth in Service Competition*, Lexington, MA: Lexington Books.
- Gronroos, C. (1993), "Toward a third phase in service quality research: challenges and Future directions", *Advances in Services Marketing and Management*, 2nd ed., Greenwich, CT: JAI Press, pp. 49-64.
- Gustafsson, A., Ekdahl, F. and Bergman, B. (1999), "Conjoint analysis: A useful tool in the design process", *Total Quality Management*, 10 (3), pp. 327-343.
- Hardie, B.G.S., Johnson, E.J. and Fader, P.S. (1993), "Modeling loss aversion and reference dependence effects on brand choice", *Marketing Science*, 12 (4), pp. 378-394.
- Hauser, J.R. and Clausing, D. (1988), "The house of quality", *Harvard Business Review*, 66 (3), pp. 63-73.
- Hellendoorn, H. (1997), "After the fuzzy wave reached Europe", *European Journal of Operational Research*, 99 (1), pp. 58-71.
- Ho, E.S.S.A., Lai, Y.J. and Chang, S.I. (1999), "An integrated group decision-making approach to quality function deployment", *IIE Transactions*, 31 (6), pp. 553-567.
- Howell, D. (2000), "Making wishes come true", *Professional Engineering*, 13 (3), pp. 39.
- Hunter, M.R. and Landingham, R.D.V. (1994), "Listening to the customer using QFD", *Quality Progress*, 27 (4), pp. 55-59.
- Hussey, M.K. (1999), "Using the concept of loss: An alternative SERVQUAL measure", *The Service Industries Journal*, 19 (4), pp. 89-101.
- Hutchinson, M.O. (1981), "The use of fuzzy logic in business decision-making", *Derivatives Quarterly*, 4 (4), pp. 53-67.
- Hwarng, H.B. and Teo, C. (2000), "Applying QFD in higher education", *Annual Quality Congress Proceedings*, pp. 255-261.
- Institute for Higher Education Policy (1999), *What's the Difference? A Review of Contemporary Research on the Effectiveness of Distance Learning in Higher Education*, Washington, DC: Institute for Higher Education Policy.



- Ives, B., Olson, M.H. and Baroudi, J. (1983), "The measurement of user information satisfaction", *Communications of the ACM*, 26 (10), pp. 785-793.
- Jaraiedi, M. and Ritz, D. (1994), "Total Quality Management applied to engineering education.", *Quality Assurance in Education*, 2 (1), pp. 32-40.
- Jiang J.J., Klein G. and Crampton S.M. (2000), "A note on SERVQUAL reliability and validity in information system service quality measurement", *Decision Sciences*, 31 (3), pp. 725-744.
- Juran, J.M. (1980), *Quality Planning and Analysis: From Product Development through Use*, New York, NY: McGraw-Hill.
- Kerka, S. (1996), "Distance Learning, the Internet and the World Wide Web", *ERIC Digest (ED295214)*, Columbus, OH: ERIC Clearinghouse on Adult, Career, and Vocational Education.
- Kettinger, W.J. and Lee, C.C. (1994), "Perceived service quality and user satisfaction with the information services function", *Decision Sciences*, 25 (5/6), pp. 737-765.
- Kettinger, W.J. and Lee, C.C. (1995), "Global measurements of information service quality: A cross-national study", *Decision Sciences*, 26 (5), pp. 569-585.
- Kettinger, W.J. and Lee, C.C. (1997), "Pragmatic perspectives on the measurement of information systems service quality", *MIS Quarterly*, 21 (2), pp. 223-240.
- Khoo, L.P. and Ho, N.C. (1996), "Framework of a fuzzy quality function deployment system", *International Journal of Production Research*, 34 (2), pp. 299-311.
- Kihara, T., Hutchinson, C.E. and Dimancescu, D. (1994), "Designing software to the voice of the customer: New uses of QFD and quantification method of type III for decomposition of the requirements", *Quality Engineering*, 7 (1), pp. 113-138.
- Kim, K.J., Moskowitz, H., Dhingra, A. and Evans, G. (1994), *Fuzzy Multicriteria Models and Decision Support System for Quality Function Deployment*, CMME Working Paper, Krannert Graduate School of Management, Purdue University, West Lafayette, Indiana.
- Kim, J.K., Han, C.H., Choi, S.H. and Kim S.H. (1998), "A knowledge-based approach to the quality function deployment", *Computers and Industrial Engineering*, 35 (1-2), pp. 233-236.
- Kim, K.J. (1997), "Determining optimal design characteristic levels in quality function deployment", *Quality Engineering*, 10 (2), pp. 295-307.
- Kim, K.J., Shin, J.S. and Moskowitz, H. (1997), "Design decomposition in quality function deployment", *Decision Making: A Volume in Honour of Stanley Zionts*, ed. By Karwan, M. H., Spronk, J. and Wallenius, J., Berlin: Springer Press.
- King, B. (1989), *Better Designs in Half the Time*, 3rd ed., Methuen, MA: GOAL/QPC.

- Klein, R.L. (1990), "New technologies for listening to the voice of the customer", *Transactions from the 2nd Symposium on Quality Function Deployment*, Nvi, MI, pp. 197-203.
- Klir, G.J. and Yuan, B. (1995), *Fuzzy Sets and Fuzzy Logic Theory and Applications*, Englewood Clifis, NJ: Prentice-Hall.
- Krishnan, M. and Houshmand, A.A. (1993), "QFD in academia: Addressing customer requirements in the design of engineering curricula", *Fifth Symposium on Quality Function Deployment*, ASI.
- Lam, K. and Zhao, X. (1998), "An application of quality function deployment to improve the quality of teaching", *International Journal of Quality and Reliability Management*, 15, pp. 389-413.
- Llosa, S., Chandon, J.L. and Orsingher, C. (1998), "An empirical study of SERVQUAL's dimensionality", *The Service Industries Journal*, 18 (2), pp. 16-24.
- Locascio, A. and Thurston, D.L. (1998), "Transforming the house of quality to a multiobjective optimization formulation", *Structural Optimization*, 16 (2/3), pp. 136-146.
- Lockamy III, A. and Khurana, A. (1995), "QFD: Total Quality Management for new product design", *The Service Industries Journal*, 18 (2), pp. 16-44.
- Lovelock, C.H. (1981), "Why marketing management needs to be different for services", *Marketing of Services*, ed. by Donnelly, J. and George, W., Chicago, IL: American Marketing.
- Lu, M.H., Madu, C.N., Kuei, C. and Winokur, D. (1994), Integrating QFD, AHP and benchmarking in strategic marketing", *Journal of Business and Industrial Marketing*, 9 (1), pp. 41-50.
- Lyman, D. (1990), "Deployment normalization", *Transanctions from the Second Symposium on Quality Function Deployment*, Novi, Mi, pp. 307-315.
- Maier, M.W. (1995), "Quantitative engineering analysis with QFD", *Quality Engineering*, 7 (4), pp. 733-746.
- Masud, A.S.M. and Dean, E. B. (1993), "Using fuzzy sets in quality function deployment", *Proceedings of the 2nd Industrial Engineering Research Conference*, pp. 270-274.
- Matzler, K. and Hinterhuber, H.H. (1998), "How to make product development projects more successful by integrating Kano's model of customer satisfaction into quality function deployment", *Technovation*, 18 (1), pp. 25-38.
- Matzler, K., Hinterhuber, H.H., Bailom, F. and Sauerwein, E. (1996), "How to delight your customers", *Journal of Product and Brand Management*, 5 (2), pp. 6-18.

- McLaurin, D.L. and Bell, S. (1993), "Making customer service more than just a slogan", *Quality Progress*, 26 (11), pp. 35-39.
- Moskowitz, H. and Kim, K.J. (1997), "QFD optimizer: A novice friendly quality function deployment decision making support system for optimizing product designs", *Computers and Industrial Engineering*, 32 (3), pp. 641-655.
- Motiwalla, L. and Tello, S. (2000), "Distance Learning on the Internet: An exploratory study", *The Internet and Higher Education*, 2 (4), pp. 253-264.
- Motwani, J., Kumar, A. and Mohamed, Z. (1996), "Implementing QFD for improving quality in education: An example", *Journal of Professional Services Marketing*, 14 (2), pp. 149-159.
- Nicholson, P.A. (1998), "Higher education in the year 2030", *Futures*, 30 (7), pp. 725-729.
- Normann, R. (1991), *Service Management: Strategy and Leadership in Service Businesses*, 2nd ed., Chichester: John Wiley & Sons.
- Oldfield, B.M. and Baron, S. (2000), "Student perceptions of service quality in a UK university business and management faculty", *Quality Assurance in Education*, 8 (2), pp. 85-95.
- Oliver, R. (1981), "Measurement and evaluation of satisfaction processes in retail settings", *Journal of Retailing*, 57, pp. 25-48.
- Pandey, A. (1992), "Quality Function Deployment: A study of implementation and enhancements", M.Sc. Thesis, Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA.
- Parasuraman, A., Berry, L.L. and Zeithaml, V.A. (1993), "Research Note: More on improving quality measurement", *Journal of Retailing*, 69 (1), pp. 140-147.
- Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1985), "A conceptual model of service quality and its implications for future research", *Journal of Marketing*, 49 (4), pp. 41-50.
- Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1988), "SERVQUAL: A multi-item scale for measuring consumer perceptions of service quality", *Journal of Retailing*, 64 (1), pp. 12-40.
- Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1991), "Refinement and reassess of the SERVQUAL scale", *Journal of Retailing*, 67 (4), pp. 420-450.
- Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1994), "Reassessment of expectations as a comparison in measuring service quality: Implications for further research", *Journal of Marketing*, 58 (1), pp. 111-124.

- Park, T. and Kim, K.J. (1998), "Determination of an optimal set of design requirements using house of quality", *Journal of Operations Management*, 16 (5), pp. 569-581.
- Peter, J.P., Churchill, G.A. and Brown, T.J. (1993), "Caution in the use of difference scores in consumer research", *Journal of Consumer Research*, 19 (1), pp. 655-662.
- Pitman, G., Motwani, J., Kumar, A. and Cheng, C.H. (1995), "QFD application in an educational setting: A pilot field study", *International Journal of Quality and Reliability Management*, 12 (6), pp. 63-72.
- Pitt, L.F., Watson, R.T. and Kavan, C.B. (1995), "Service quality: A measure of information systems effectiveness", *MIS Quarterly*, 19 (2), pp. 173-187.
- Prasad, B. (1997), *Concurrent Engineering Fundamentals: Integrated Product Development*, 2nd ed., Upper Saddle River, NJ: Prentice-Hall PTR, Inc.
- Prasad, B. (1998), "Review of QFD and related deployment techniques", *Journal of Manufacturing Systems*, 17 (3), pp. 221-234.
- Rao, C.P. and Kelkar, M.M. (1997), "Relative impact of performance and importance ratings on measurement of service quality", *Journal of Professional Services Marketing*, 15 (2), pp. 69-86.
- Raynor, M.E. (1994), "The ABCs of QFD: Formalizing the quest for cost-effective customer delight", *National Productivity Review*, 13 (3), pp. 351-357.
- Reich, Y. (1996), "AI-supported quality function deployment", in *Artificial Intelligence in Economics and Management: An Edited Proceedings on the Fourth International Workshop*, ed. By Edin-Dor, P., Boston, Mass: Kluwer Academic, pp. 93-106.
- Revelle, J.B., Moran, J.W. and Cox, C.A. (1997), *The QFD Handbook*, New York: John Wiley & Sons.
- Saaty, T.L. (1980), *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*, New York: McGraw-Hill.
- Shank, M.D., Walker, M. and Hayes, T. (1995), "Understanding professional service expectations: Do you know what our students expect in a quality education", *Journal of Professional Services Marketing*, 13, pp. 71-89.
- Shillito, M.L. (1994), *Advanced QFD: Linking Technology to Market and Company Needs*, New York: John Wiley & Sons.
- Shin, J.S. and Kim, K.J. (1997), "Restructuring a house of quality using factor analysis", *Quality Engineering*, 9 (4), pp. 739-746.

- Shin, J.S., Fong, D.K.H. and Kim, K.J. (1998), "Complexity reduction of a house of quality chart using correspondence analysis", *Quality Management Journal*, 5 (4), pp. 46-58.
- Sonwalkar, N. (2002), "A new methodology for evaluation: The pedagogical rating of online courses", *Syllabus*, 15 (6), pp. 18-21.
- Sriraman, V., Tosirisuk, P. and Chu, H.W. (1990), "Object-oriented databases for quality function deployment and Taguchi methods", *Computers and Industrial Engineering*, 19 (1-4), pp. 285-289.
- Stafford, B. (2001), "Risk management and Internet Banking: What every banker needs to know", *Community Banker*, 10 (2), pp. 48-49.
- Sullivan, L.P. (1986), "Quality function deployment", *Quality Progress*, 19 (6), pp. 39-50.
- Sullivan, L.P. (1988), "Policy Management through quality function deployment", *Quality Progress*, 26 (12), pp. 39-50.
- Tan, K.C. and Shen, X.X. (2000), "Integrating Kano's model in the planning matrix of quality function deployment", *Total Quality Management*, 11 (8), pp. 1141-1151.
- Taylor, J.C. (1995), "Distance education technologies: The fourth generation", *Australian Journal of Educational Technology*, 11 (2), pp. 1-7.
- Teas, R.K. (1993), "Expectations, performance evaluation and consumer's perception of quality", *Journal of Marketing*, 57 (4), pp.18-34.
- Teas, R.K. (1994), "Expectations as a comparison standard in measuring service quality: An assessment of a reassessment", *Journal of Marketing*, 58 (1), pp. 132-139.
- Thorpe, M. (1988), *Evaluating Open & Distance Learning*, Longman Open Learning.
- Thurston, D.L. and Locascio, A. (1993), "Multiattribute design optimization and concurrent engineering", *Concurrent Engineering: Contemporary Issues and Modern Design Tools*, ed. By Parsaei, H.R. and Sullivan, W.G., Cambridge: Chapman & Hall, pp. 207-230.
- Tsaur, S.H., Chang, T.Y. and Chang, H.Y. (2002), "The evaluation of airline service quality by Fuzzy MCDM", *Tourism Management*, 23 (2), pp. 107-115.
- Van Dyke, T.P., Kappelman, L.A., and Prybutok, V.R. (1997), "Measuring information systems service quality: Concerns on the use of the SERVQUAL questionnaire", *MIS Quarterly*, 21 (2), pp. 195-208.
- Van Dyke, T.P., Prybutok, V.R. and Kappelman, L.A. (1999), "Cautions on the use of the SERVQUAL measure to assess the quality of information systems services", *Decision Sciences*, 30 (3), pp. 877-891.

- Verduin, J.R. and Clark, T.A. (1991), *Distance Education: The Foundations of Effective Practice*, San Francisco, CA: Jossey-Bass Publishers.
- Viswanathan, M. (1999), "Understanding how product attributes influence product categorization: Development and validation of fuzzy set-based measures of gradedness in product categories", *Journal of Marketing Research*, 36 (1), pp. 75-95.
- Wang, H., Xie, M. and Goh, T.N. (1998), "A comparative study of the prioritization matrix method and the analytic hierarchy process technique in quality function deployment", *International Journal of Production Research*, 37 (4), pp. 899-916.
- Wang H., Xie, M. and Goh, T.N. (1999), "Service quality of Internet search engines", *Journal of Information Science*, 25 (6), pp. 499-507.
- Wang, J. (1999), "Fuzzy outranking approach to prioritize design requirements in quality function deployment", *International Journal of Production Research*, 37 (4), pp. 899-916.
- Wasserman, G.S. (1993), "On how to prioritize design requirements during the QFD planning process", *IIE Transactions*, 25 (3), pp. 59-65.
- Willis, B. (1993). *Distance Education: A Practical Guide*, Educational Technology Publications, NJ: Englewood Cliffs.
- Wolfe, M. (1994), "Development of the city of quality: A hypertext-based group decision support system for quality function deployment", *Decision Support Systems*, 11 (3), pp. 299-318.
- Wotruba, T.R. and Tyagi, P.K. (1991), "Met expectations and turnover in direct selling", *Journal of Marketing*, 55 (3), pp. 24-35.
- Wulf, K. (1996), "Training via the Internet: Where are we?", *Training and Development*, 50 (5), pp. 50-55.
- Xia, X., Wang, Z. and Gao, Y. (2000), "Estimation of non-statistical uncertainty using fuzzy set theory", *Measurement Science & Technology*, 11 (4), pp. 430-435.
- Zadeh, L.A. (1965), "Fuzzy sets", *Information and Control*, 8, pp. 338-353.
- Zadeh, L.A. (1975), "The concept of a linguistic variable and its application to approximate reasoning", *Information sciences*, 8, pp. 199-249 (I), pp. 301-357(II).
- Zaltman, G. and Higie, R.A. (1993), *Seeing the Voice of the Customer: The Zaltamn Metaphor Elicitation Technique*, Working Paper, Report No. 93-114, Cambridge, MA; Marketing Science Institute.
- Zeithaml, V., Berry, L. and Parasuraman, A. (1993), "The nature and determinant of customer expectation of service quality", *Journal of the Academy of Marketing Science*, 21 (1), pp. 1-12.

Zeithaml, V.A. and Bitner, M.J. (1996), *Services Marketing*, New York, NY: McGraw-Hill.

Zhang, X., Bod, J. and Ren, S. (1996), "Neural networks in quality function deployment", *Computers and Industrial Engineering*, 31 (3-4), pp. 669-673.

Zhao, R. and Govind, R. (1991), "Algebraic characteristics of extended fuzzy number", *Information Science*, 54, pp. 103-130.

Zimmermann, H.J. (1996), *Fuzzy Set Theory and its Applications*, 3rd ed., Boston: Kluwer Academic Publishers.

Zultner, R.E. (1993), "Priorities: The analytic hierarchy process in QFD", *Transactions from the Fifth Symposium on Quality Function Deployment*, Novi, MI, pp. 133-143.

## **A SURVEY ON STUDENT ACCOMMODATION SERVICES BY THE NATIONAL UNIVERSITY OF SINGAPORE**

### **General Information About Respondent**

Please tick your answers for the following questions

1. You are:

- ☐ An undergraduate student                      ☐ A graduate student  
☐ Other category of student

2. You are:

- ☐ A Singaporean or Permanent Resident   ☐ An international student

3. Where do you live now?

- ☐ Prince George's Park                      ☐ Gillman Heights  
☐ Eusoff Hall                                      ☐ Kent Ridge Hall  
☐ KEVII Hall                                      ☐ Raffles Hall  
☐ Sheares Hall                                      ☐ Temasek Hall  
☐ Kuok Foundation House and Extension Block A

4. How long have you lived in residences provided by NUS?

- ☐ less than three months                      ☐ three months to one year  
☐ more than one year

### **Accommodation Service Quality**



Please tick the most appropriate answers for questions 1-20:

Scale	[1]	[2]	[3]	[4]	[5]
	Strongly Disagree	Slightly Disagree	Neutral	Slightly Agree	Strongly Agree

1. A cozy environment for studying is provided.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

2. Internet facilities are easily available.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

3. Noise is sufficiently controlled at this residence.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

4. Various sports facilities are nearby.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

5. A lot of activities are organized for residents to encourage communication and generate friendship.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

6. Various entertainment facilities are available and can be enjoyed for free or for a small fee.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

7. Transportation to most parts of campus and to the city is available.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

8. Food is conveniently available around the residence and different varieties are provided for both the local and international students.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

9. Household cleanliness services are offered as an option for resident.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

10. Living necessities such as grocery can be easily accessed even late at night.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

11. Medical services offering simple medication can be accessed 24 hours a day.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

12. Damaged facilities are repaired on time.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

13. Security is well implemented around the residential areas.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

14. Different types of rooms are offered according to the students' preferences.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

15. Students can choose their own roommates/flatmates.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

16. Resident Assistants can be easily approached in case of difficulties.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

17. Accommodation services information on the website is up-to-date and thorough.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

18. A sufficient number of public telephones are provided in the residence.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

19. Basic appliances (e.g., for cooking and laundry) are easy to access.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

20. There are ATMs nearby for easy access.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Agree

*Thank you very much for your kind assistance!*

www.edu-edu.com.cn

## 关于华夏大地教育网网上课服务质量的调查

△ 为了让您能够得到更好的服务,请选择您认为最合适的答案。希望得到您的合作,您的私人资料将会被保密。

## 基本情况 ↓

1. 性别: ☒ 男 ☐ 女

2. 年龄: ☒ 20岁及以下 ☐ 21-30岁 ☐ 31-40岁 ☐ 41岁以上

3. 教育状况: ☒ 高中及以下 ☐ 中专及技校 ☐ 大专 ☐ 本科 ☐ 硕士及以上

4. 您的上网经验? ☒ 不到一年 ☐ 一年到三年 ☐ 三年以上

5. 您在华夏大地教育网上选修的是哪一类课程?

☒ 自学考试 ☐ 注会考试 ☐ 国家司法考试 ☐ 注册资产评估师 ☐ Adobe培训 ☐ 企业培训

☐ 项目管理 ☐ 汉语培训

## 网上课服务质量调查 ↓

△ 请对各项的重要性和满意度做出您的选择。

	重要性					满意度				
	很重要	重要	比较重要	有点重要	不重要	很好	好	一般	差	很差
1. 课程材料和教师的讲解都是准确无误的。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. 能从网上方便地观看及下载课程材料和讲座等。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. 对使用网上材料所需的软件提供下载。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. 有聊天室,答疑室及电邮地址等让您和教师及其他同学能够同步或异步地进行交流。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. 有多种在线测试方式(带自动判卷功能)让您便于进行自测。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. 提供与学习内容相关的各种参考资料(如学术期刊,文章,录像和录音等)的链接。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. 能方便地与教师及相关工作人员取得联系。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. 教师和工作人员一直乐于帮助您。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. 在学习过程中教师及相关工作人员给予了您个人的关注。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. 通过电邮通知您相关消息(如教师在线答疑时间等)。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. 您一直能连上网站。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. 网站易于浏览。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. 有图画,动画等使网页看来赏心悦目。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. 网站的内容和信息组织合理并标示明确。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. 网站内容被及时更新。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. 有网站导航等帮助您学习如何使用该网站。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. 网站提供电邮或热线电话等方式来帮助您。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. 教师和工作人员回复的电邮和电话与问题相关并提供准确信息。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. 能够按时提供约定的服务。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. 迅速处理您的反馈信息。	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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### A SURVEY ON SERVICE QUALITY OF WEB-BASED COURSE OFFERED BY HUAXIA DADI DISTANCE LEARNING SERVICES COMPANY

△ To provide better services, please indicate your selection for the following statements. We hope to receive your kind support. The privacy of respondents will be kept strictly confidential.

#### ↓ GENERAL INFORMATION ABOUT RESPONDENT

1. Gender: ☒ Male ☐ Female
2. Age: ☒ 20 or below ☐ 21-30 ☐ 31-40 ☐ 41 or above
3. Education: ☒ Secondary or below ☐ Junior College ☐ Poly/Diploma ☐ Bachelor ☐ Master or above
4. Internet experience? ☒ Less than one year ☐ One to three years ☐ Three years or longer
5. Which kind of program are you taking on Huaxia Dadi Distance Learning Website?
- ☒ Self Study Exams ☐ Exams for Certified Public Accountants ☐ Lawyer Qualification Exams
- ☐ Exams for Certified Public Assessors ☐ Adobe Training ☐ Enterprise Management ☐ Project Management ☐ Degree and non-degree Chinese Language programs

#### ↓ WEB-BASED COURSE SERVICE QUALITY

△ Please tick the most appropriate answers for questions 1-26

	Level of Importance					Level of Satisfaction				
	Very Important	Important	Fair	Unimportant	Very Unimportant	Excellent	Good	Fair	Poor	Very Poor
1. Course materials and instructions should be accurate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Course materials and lectures should be accessed conveniently online.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. There should be hotlinks to get the software for viewing online materials and lectures easily.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Chat rooms, forums and email lists should be available for instructors and students to interact.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Online quiz and exam with real-time grading should be available.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Reference links (links to related journals, articles, videos, etc.) should be available.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Instructors and other staff should be easy to contact.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Instructors and other staff should always be willing to help you.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Individual attention should be given to students based on records and performance.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Emails should remind students for related information (such as update course materials, lectures and coming activities, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. Websites should be accessible all the time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Website should be easy to navigate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. Website should be visually appealing.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. The contents and information of website should be clearly labeled and organized.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. The contents and information of course website should be updated timely	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. There should be clear instructions for students to use the website.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. Email and hotline are provided for help.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. E-mail and call responses should be relevant and accurate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. Services should be provided on time as planned.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. Students' feedback should be processed promptly.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. Emails or questionnaires should be used to conduct student satisfaction surveys.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. There should be various modes of payment for paying services.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. Firewall should be used to secure online monetary transaction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>△ In general, your overall degree of satisfaction with Huaxia Dadi Distance Learning website:</p> <p><input type="radio"/> Excellent    <input type="radio"/> Good    <input type="radio"/> Fair    <input type="radio"/> Poor    <input type="radio"/> Very Poor</p> <p>△ What other attributes do you think are essential for a good web-based course program? (optional)</p> <p><input type="text"/></p> <p><input type="text"/></p> <p><input type="text"/></p>										
<p style="text-align: center;"> <input type="button" value="Submit &gt;&gt;"/> <input type="button" value="Reset &lt;&lt;"/> </p>										